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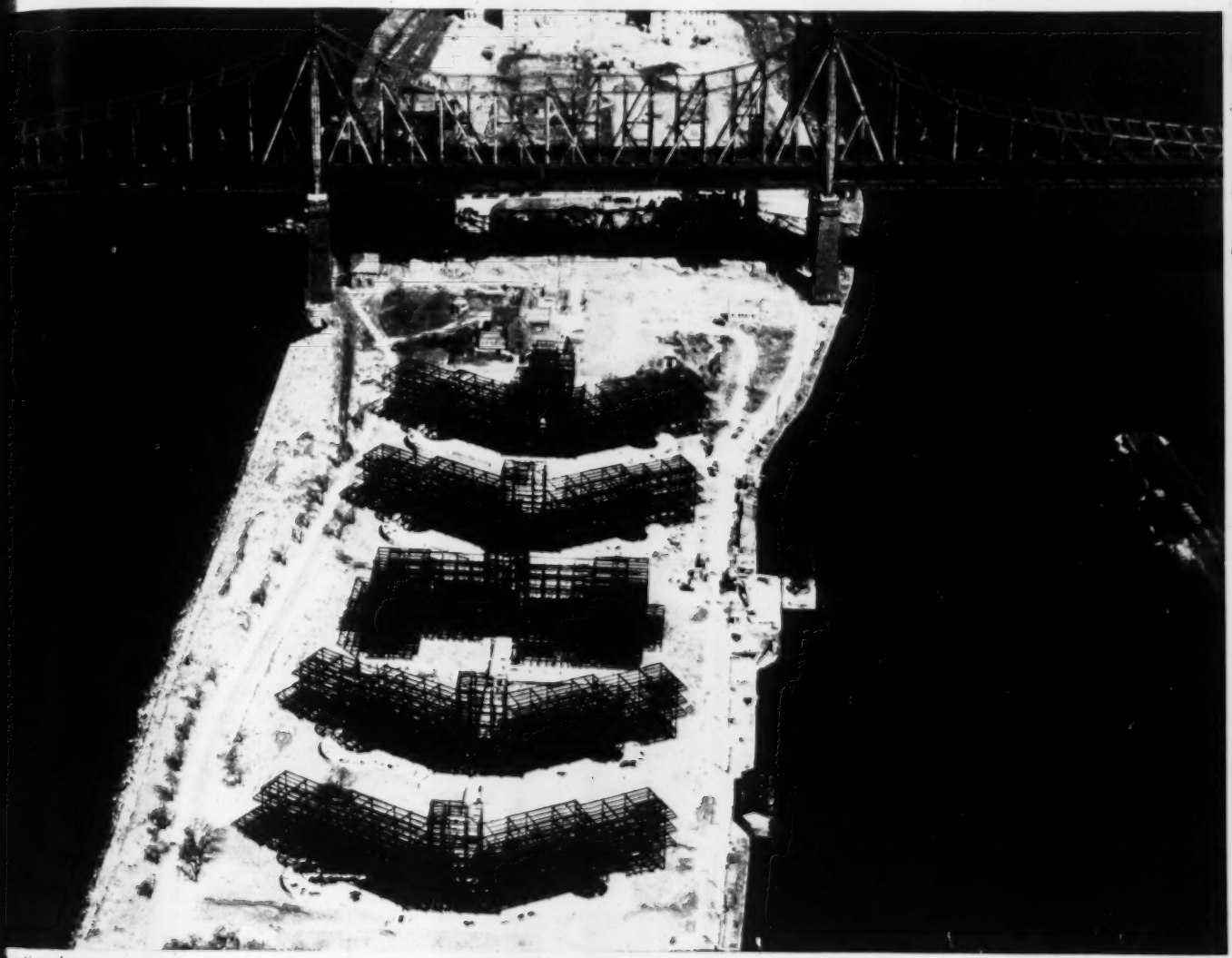

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Steel frames for five hospital buildings south of the Queensboro Bridge on Welfare Island, New York

Santa Fe Railway Completes New Link in Line to Gulf . . . New Rating Plan Cuts Contractors Insurance Costs . . . Industrial Water Supply for Birmingham . . . Leaks Checked in Grand Coulee Cofferdam . . . A Record-Size Bascule Bridge . . . Superstreet Designs for Omaha . . . Squeeze Test for Integrity of Soil Samples . . . Additional Data on Failure of the Golden Gate Bridge Scaffold.

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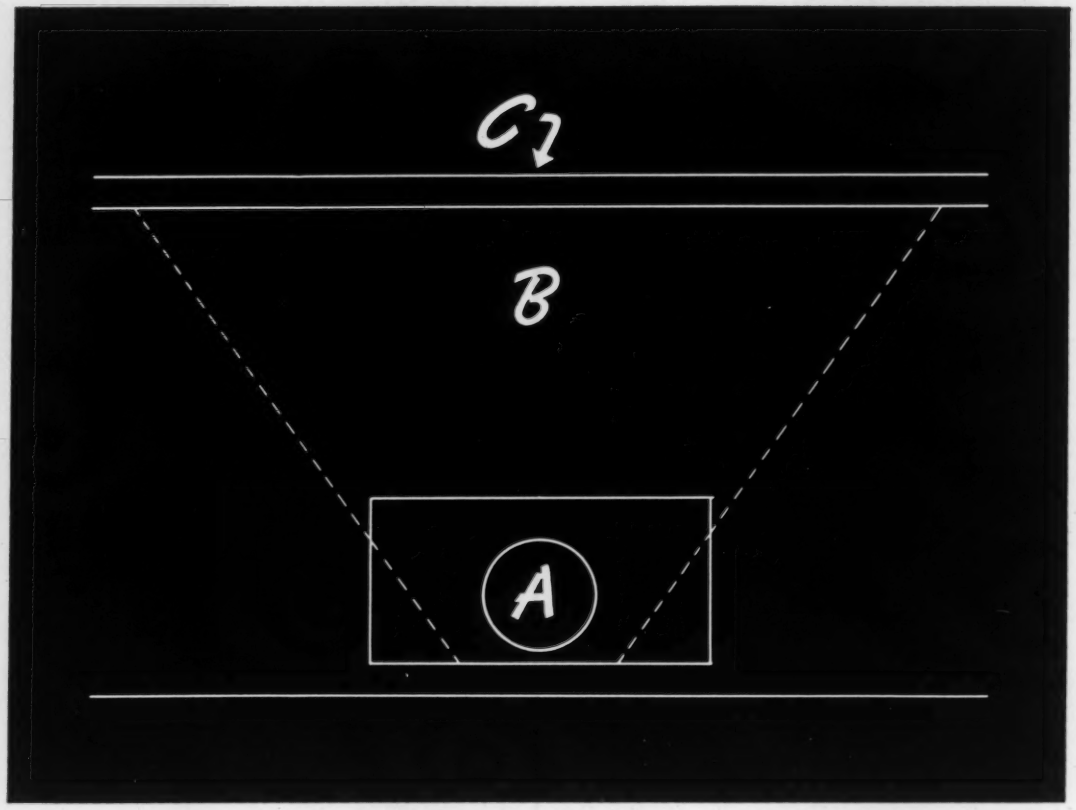

USING THE SIMPLE FORMULA $X = A + B + C$

• Suppose you are going to install a pipe culvert and you want to determine the comparative cost of various types. To obtain a *true* answer, you must consider the cost of the pipe itself (A): *plus* the cost of installing and backfilling (B): *plus* the cost of the road surface above (C).

Remember, a pipe is not a culvert until it is installed. A low-priced pipe costs just as much to install as a pipe that is more durable. Furthermore, in case of failure, the entire volume of fill and surfacing supported by the culvert is likely to be affected.

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A Big Job Still Ahead

LAST week, in commenting on the President's recent statement that federal expenditures should be shifted from public works that involve modern methods and materials to those that put a premium on strong backs and primitive methods, this page suggested that his announced purpose of curbing an inflationary trend was, in fact, quite secondary to other and not so economic objectives.

This intended no reflection on those objectives, but it would be too bad if his statement were to mislead public thinking on certain matters of concern to the construction industry.

FIRST, it should be understood that such a curtailment of PWA expenditures would not put a serious crimp in construction volume. A few years ago, when total construction volume had fallen to about $2.5 billion, federal emergency projects were life-savers; but today, with an estimated volume of $6.5 billion for the year, all Mr. Ickes' expenditures that *can* be curtailed probably would comprise but a small per cent of the total. As the trend is consistently toward an increasing volume of private and other non-federal construction, the President's program, even if it were followed, cannot halt the progress of construction toward higher levels.

A second point is that, despite its progress, construction still is far short of an inflation volume. The price increases cited by the President do not result from excessive construction buying. Construction is, in fact, less than 70 per cent of normal and is an even smaller percentage of what it soon must be if we are to make up the present deficiency in fixed facilities.

A third factor is this deficiency. Leave aside, for the time being, the vast need for new construction and rehabilitation of private facilities. In its recent study of "The Recovery Problem in the United States," the Brookings Institution throws some light on this widely misunderstood subject of public works construction. It finds that, despite the strenuous efforts by federal and local governments throughout the depression to maintain the volume of public works, expenditures for such purposes were in fact seriously reduced. It reminds us that, although the average annual physical volume of public works construction from 1930 to 1936 was only about 10 per cent below that from 1925 to 1929, "it must be remembered that prior to 1929 public works construction and maintenance had been expanding rapidly and that a mere cessation of growth may represent in effect an accruing deficiency in relation to the prosperity demands of the nation for the services of publicly owned durable goods. * * *"

The use of highways in 1936, it goes on, exceeded 1929 by 20 per cent. Enrollment in public schools was up 7 per cent. The use of water works and sewers was certainly higher. "Insofar, therefore, as construction expenditures were needed to offset the current consumption of public capital goods, the depression justified no reduction."

AFTER pointing out that the requirements of a growing and mobile population and of higher standards of service had been evaded during the depression, the report warns us that the construction of new streets, water lines, sewers and schools to accomodate new communities "has been no more permanently avoided than has the residential building itself. It has accumulated as a backlog for the future."

The Brookings report points out also another fact that frequently has been noted on this page, i.e., that "technological obsolescence affects public property no less than private. Roughly half of the present surfaced mileage was constructed in the days of Model T. Much of this mileage is still narrow and tortuous with unbanked curves and poor visibility. Recent advances in highway engineering and the technique of traffic control have made obsolete a considerable fraction even of the mileage more recently constructed, particularly trunk lines between metropolitan centers."

In concluding its estimate of the public works outlook the report says: "It is quite impossible to make any measurement of future requirements for public works construction and maintenance. * * * However, in the light of the accumulation of repair work, the great amount of urban street reconstruction that should be undertaken and the requirements which arise from the growth and shifting of population, it would seem that *the needs over the next five years are of a magnitude at least equal to the actual construction of the late twenties.*" The italics are by this writer.

Willard Chevalier

ENGINEERING NEWS-RECORD Published every Thursday. Vol. 118, No. 16. Price 25c per copy. Subscription, domestic, Canada, Mexico, Central and South American countries, $5 per year. All other countries, $9 a year or 36 shillings. Entered as second-class matter October 29, 1936, at the Post Office at Albany, N. Y., under the act of March 3, 1879. Printed in U. S. A. Cable address "McGrawhill New York." Member A.B.P. Member A.B.C.

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Editorial and Executive Offices: 330 West 42d St., New York. Publication Office: 99-129 N. Broadway, Albany, N. Y. Branch Offices: 520 N. Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, W. C. 2, England; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta, Ga.

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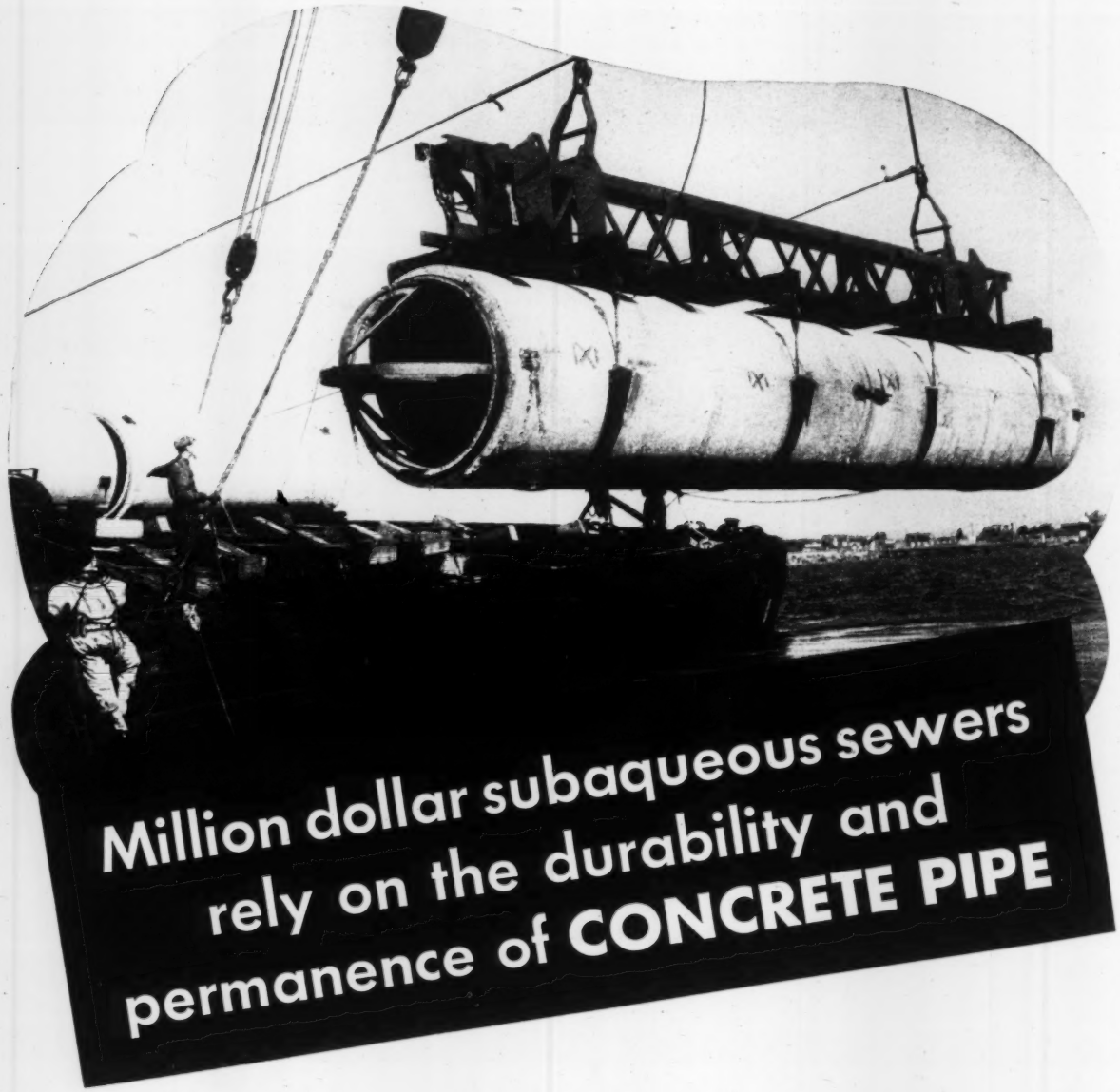

Million dollar subaqueous sewers rely on the durability and permanence of CONCRETE PIPE

Two 24-ft. lengths of 72-in. reinforced concrete pipe weighing 44 tons being lowered into position off Coney Island, New York City. This project is being built by City of New York with WPA funds. Thomas W. Hammond, Commissioner of the Department of Sanitation; Walter D. Binger, Deputy Commissioner, in charge of engineering; plant design and construction by Richard H. Gould, Chief Engineer and William L. Sylvester, Designing Engineer; Alfred R. Glock, Resident Engineer.

ABATEMENT of New York harbor pollution and health protection for the millions of bathers at Coney Island beaches required the building of a new sewage treatment plant at Coney Island. And part of that job was constructing a sewer with a 6,375-ft. subaqueous section of 72-in. concrete pipe.

Double 24-ft. sections with watertight joints were lifted and laid with a steel truss "strong back" and the successive sections bolted together by a diver, three 48-ft. sections being laid each working day. With a shell thickness of 7 in. and a weight of 22 tons, these 72-in. pipe sections are believed to be the longest lengths ever cast for pipe of this diameter.

Well-engineered and well-constructed, this job is typical of the many sewers and sewerage systems throughout the country for which concrete is being used. Strong, permanent and moderate in cost, concrete pipe is the answer to a wide range of problems; whether the sewer is 12 inches or 12 feet in diameter.

The cheapest insurance of the success of a sewer job is to place the work in the hands of a competent sanitary engineer.

PORTLAND CEMENT ASSOCIATION, Dept. 4d-17, 33 W. GRAND AVE., CHICAGO, ILL.

A National Organization to Improve and Extend the Uses of Concrete

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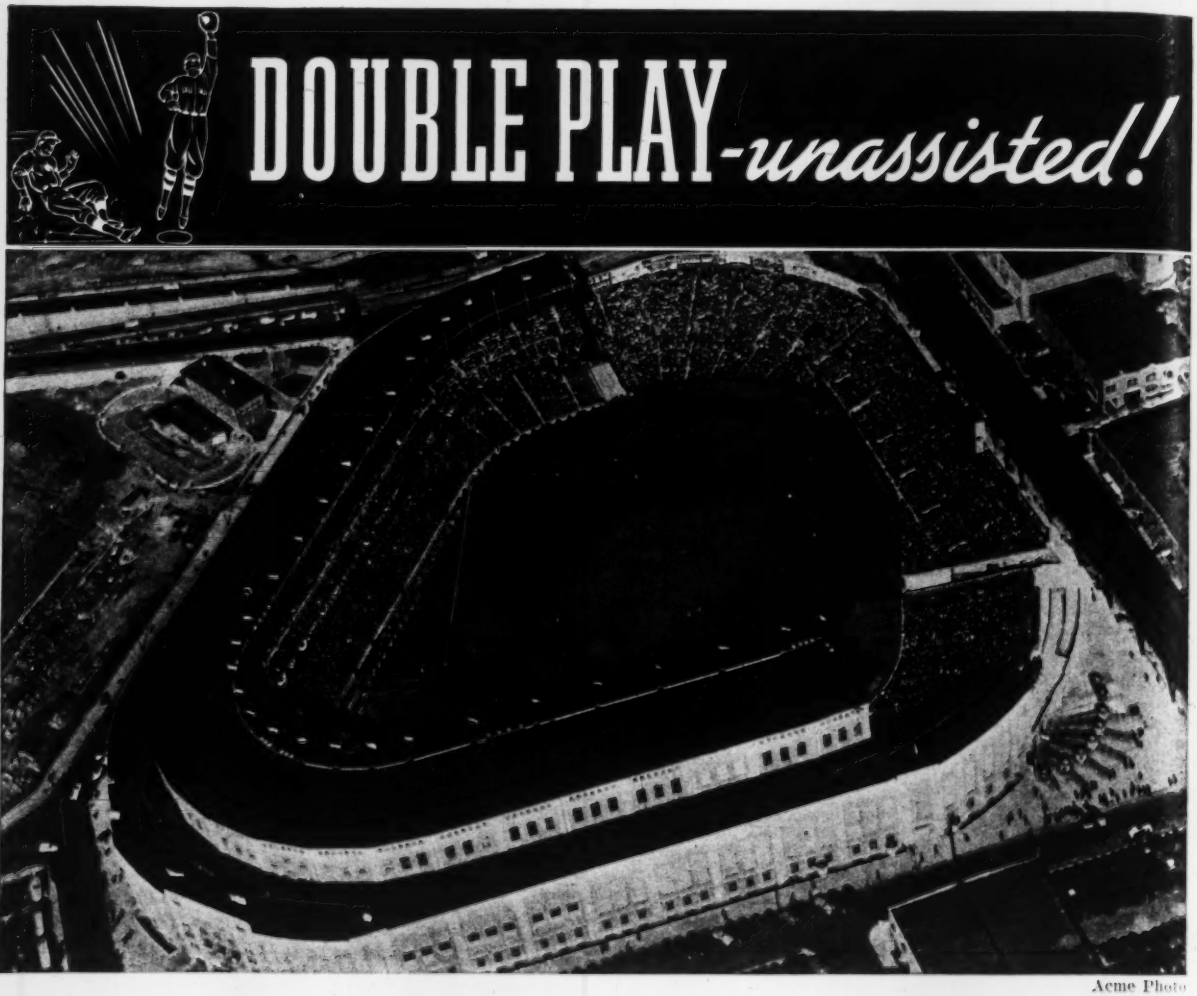
City Engineering— Next week's issue will be given over to present problems of the city engineer. A group of well-known authorities will discuss financing current work, organization, water supply and sanitation, street maintenance, planning for future work, and the city engineer's functions.



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Thirteen years ago, rust-resisting Toncan Iron was installed for the louvres at Yankee Stadium, New York, home of the present world champion baseball team. Recently, when a new addition was built, the engineers, the Osborn Engineering Co., Cleveland, again used this rust-resisting metal — because Toncan Iron had served its purpose so well that the maintenance men had forgotten about it. Corrosion and high maintenance cost are "out" — an unassisted double play by Toncan Iron.

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ENGINEERING NEWS-RECORD

April 22, 1937

FIG. 1—WIDE CUTS for free drainage of the roadbed and easy curves characterize the new Santa Fe line. This picture was taken before the ballasting had been completed.

New Rail Link to Gulf Completed

Extensive mechanization of construction on new Santa Fe Ry. line through drought areas in Colorado and Oklahoma — Track laid out for modern high-speed service

By G. L. Mercer

Assistant Engineer, A. T. & S. F. Ry., Amarillo, Texas.

CONSTRUCTION of new railroad lines during the past few years has dwindled to the point where construction of a line 110 miles long becomes an item of real news. Such a line was built by the Santa Fe last year and was put into service in February. It is notable not alone as the only large piece of railroad construction in 1936 but also as an example of modern trends in mechanization of grading operations and in laying out track for high-speed service.

On April 20, 1936, the Atchison, Topeka and Santa Fe Railway Co. let a contract for the construction of a line from Boise City, Okla. to Las Animas, Colo., a distance of 115.2 mi., of which 110.5 miles is new line and the remainder is existing track. This line is part of a project that originally was expected to have been finished three years ago, but which, because of the depression, had never been completed. In 1930 construction of a line was begun from Amarillo, Tex., to Las Animas, but the work was completed only to Boise City, a distance of 124 miles, when it was shut down in 1932.

The purpose of the new line is to provide the Santa Fe with a direct route from Denver and other Colorado points to Galveston on the Gulf of Mexico. It gives the Santa Fe the shortest rail route between Denver and Amarillo, a distance of 441 mi., as compared with the previous distance of 669 mi. by its own lines and 465 mi. over the Burlington lines. In addition to providing a direct north-and-south route to the Gulf, completion of the new line will open up some territory that is fairly productive in times of normal rainfall.

The country through which the line passes is part of the great central territory which has been severely drought-stricken during the past three years. The mean annual rainfall in the region is around 15 in., but in recent years it has been considerably less than this average and, therefore, agriculture in the area is in a depressed condition. However, much of the soil is quite fertile, and in times of normal rainfall it produces good crops of wheat, broomcorn, stock-feed and grass. The land is typical of a large part of the West and Southwest; mostly treeless plains with few watercourses, and those are dry or nearly so except immediately after rains. The line, running at about right angles with the general slope of the terrain, crosses most of the drainage nearly squarely. Much of the land adjacent to the main stream channels is badly broken up by erosion, but between stream courses the surface of the region is quite flat.

Beginning at Boise City where good terminal facilities were built in 1932, the line takes off at mile 122.8, which mileage is measured from the junction with the main line 1.4 mi. east of the station at Amarillo. For seven miles it crosses a flat plain, then breaks down sharply to the Cimarron River at mile 137.5. Crossing the river, which at this point has a wide, sandy bed, normally with only a trickle of water on the surface, the line ascends sharply to the Oklahoma-Colorado state line 20 mi. from Boise City, then climbs gently to cross a rolling plain with numerous dry arroyos to Springfield at mile 172.3. Connecting into the Dodge City-Pritchett line half a mile east of Springfield, the new line follows the old track for about two miles and then leaves the latter taking a northwesterly direction across a rather heavily rolling plains country. It crosses Bear and Plum Creeks and climbs to a summit at mile 188, from where the grade drops rapidly for three miles to Two Buttes Creek. Thence it ascends sharply for 4.5 mi. to the highest point on the line at El. 4,759, then gradually descends over fairly smooth ground for 23 mi., approximately parallel to Cottonwood and Rule creeks, crossing these drainages at mile 206 and 218 respectively. From the Rule Creek crossing, the grade, genrally rolling, climbs eight miles to a low summit at El. 4,220, then drops on a fairly uniform grade to a point on the main track, 2.4 mi. east of Las Animas and 235 mi. from Amarillo. The last 2.5 mi. of the new line pass through the Bent County Irrigation District in the Arkansas River valley. The accompanying map shows the general features of the line, while the condensed profile shows the elevations and general rise and fall.

The maximum grade is one per cent, with compensation for curvature of 0.04 per cent per degree of curve. The original location was run on the basis of maximum curvature of four degrees, but in constructing the line this maximum was reduced to 1 deg. 30 mi. to conform with improvements being made on other parts of the railroad. This curve reduction required considerable extra preliminary work on the part of the engineering forces in revamping the location survey.

Curves are spiraled and superelevated in accordance with the following:

Degree of curve Deg.	Min.	Length of spiral in feet	Superelevation in inches
1	30	178	¾
1	00	340	1½
1	30	410	2

These long spirals conform with main line standards, hence, if it is ever desired to use high speeds on the line, the additional track work will be considerably simplified.

Relatively few unusual or difficult construction features were encountered in building the line. The early part of the work was considerably hindered by

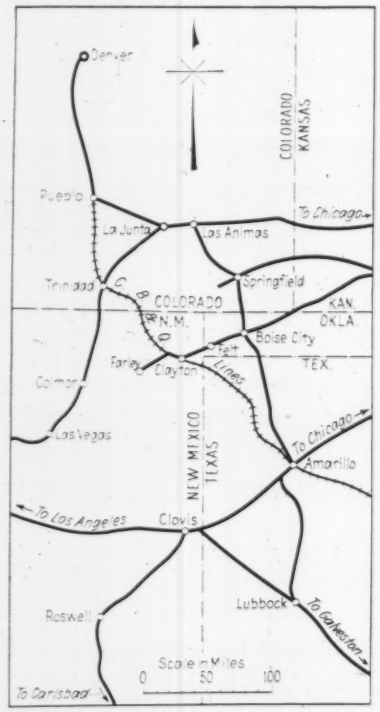


FIG. 2—THE NEW LINE of the Santa Fe reduces the distance from Denver to the Gulf over Santa Fe tracks by 228 miles.

sand and dust storms, and in May there was some high water. However, work was not far enough along for much damage to be done; in fact, the high water permitted a closer study to be made of the drainage situation, and a number of drainage structures were moved or enlarged as a result of additional information gained at that time. All of the line was accessible to automobiles and trucks, and connections at Boise City, Springfield and Las Animas with lines already built helped speed construction very materially by permitting the work to be attacked at several points simultaneously.

Material yards, operated by railway company forces, were established at Boise City, Springfield and Las Animas. These yards took care of distribution of all material supplied by the railway — such as ties, rails and track fastenings, all creosoted culvert and bridge lumber and piling; fencing, signs, crossing plank and cement. Building materials were supplied by the contractor and were hauled to the site in railroad cars after track was laid.

The roadbed section was constructed with a 20-foot crown and 1½ to 1 slopes for fills. Cuts were made with a 26-ft. base including a cut ditch one foot deep and slopes of 1 to 1 in earth, ½ to 1 in "loose rock", and ¼ to 1 in solid rock.

Grading work was only moderately heavy, except that from mile 130 to 138.5 and from mile 188 to 191.5. The rough country south of the Cimarron River at the former location involved some heavy work, with cuts 25 ft. deep and fills as high as 40 ft. Near mile 188, the summit cut was 4,700 ft. long with a maximum depth of 37 ft., and contained 170,000 cu.yd. of material. Practically all of the heavier cuts were solid rock overlaid with several feet of earth, while the lighter cuts in general were classified as earth with some loose rock. The grading quantities for the entire line were as follows:

Embarkment	3,130,000 Cu. Yd.
Earth excavation	770,000
Loose rock excavation	200,000
Solid rock excavation	340,000

Power equipment speeds work

As on the large grading jobs of the present day, the work was characterized by the predominance of mechanical equipment in excavating and handling materials. Only a very small part of the work was done with teams and fresnos, due partly to the scarcity of feed in the territory. However, the economy and efficiency inherent in improved power equipment were chiefly responsible for its widespread use on this work. Quite a variety of equipment was used, including diesel-powered crawler shovels, carryalls, tumblebugs, bulldozers, tractor-drawn elevating graders and a large number of automobile trucks. The efficiency of this mechanical equipment was evidenced by the speed with which the work was completed. Grading was started on May 1 and was finished by Dec. 1.

Steel bridges on concrete substructures were built at the crossings of the Cimarron River and Two Buttes Creek. At the Cimarron where there was evidence that a previous high-water section had had an area of 12,000 sq. ft., the line crosses 28 ft. above stream bed. The structure installed at that point consists of three 102-ft. and two 106-ft. deck girders on concrete piers, with pile trestle approaches at each end, making a total of 983 ft. of bridge. As previously stated, the riverbed is wide and sandy at this point, but good bottom for the piers was found on rock 18 ft. below bed of the stream.

Two Buttes Creek is crossed 50 ft. above streambed on one 44-ft. and two 102-ft. deck girder spans with one 252-ft. pile-trestle approach. The piers are founded on hard shale 16 ft. below the channel bed. The pile-trestle is protected from possible scour behind the end pier by a reinforced concrete slope wall 9 in. thick, 460 ft. long, and 18 ft. wide measured along the 1½ to 1 slope of the creek bank.

Cement used in the substructures of these two bridges, as well as in all other concrete work on the line, was supplied by the railway company at a price to the contractor fixed by agreement. Gravel was hauled from points on the Canadian River north of Amarillo and from pits along the Arkansas River at Pueblo, Colo. Sand was obtained locally from a number of pits opened up

along the line. The concrete work on the bridges was done under contract, but the steel spans were furnished and placed by the railway company.

Trestles built of treated timber

The remainder of the larger drainage channels on the line were spanned by creosoted pile-trestle bridges. In general, these were made open deck, but three of them were made ballast deck on account of being on curves. Many smaller openings were spanned with pile bridges having T-rail stringer decks. Altogether, 5,905 ft. of pile-trestle and T-rail bridges were constructed, requiring 96,000 lin. ft. of creosoted piling and 750,000 ft.b.m. of creosoted timber. A notable feature in regard to all of the wooden bridge structures is that practically all timbers were cut to correct lengths, bored for bolts and connections, and then creosoted at railway company plants before being shipped to the job. A life of from 30 to 35 years with comparatively light maintenance expense is expected from these timber structures.

Pile-driving was done with two portable or land drivers on caterpillars and one large skid driver, so that there was no need of temporarily cribbing openings or holding up tracklaying for the pile-driving. Culverts on the line consist of concrete boxes for large openings, wood boxes, concrete or cast-iron pipe for smaller openings. All pipe culverts were provided with concrete headwalls and aprons.

Reconditioned rail used

Track is laid with first grade secondhand 90-lb. rail and fastenings, with 20 ties per 33-ft. rail on main track and 16 ties per 33-ft. rail on passing and other side tracks. In addition to being sorted in the material yard, the rails were ground at the ends to remove projecting lips or burrs, and oiled over the length covered by the joints. The grinding permitted greater accuracy in spacing the rails for proper expansion in track, while the oiling checks corrosion under the bars. Grinding was done with a 6-in. carborundum wheel with flexible shaft operated by a gas-electric motor mounted on a small hand truck. The joint bars were re-formed in the shop before delivery, to give them a better fit.

Ties are creosoted pine with two tie plates and four spikes per tie.

Track laid with pioneer car

Ties and fastenings were distributed by automobile truck just far enough in advance of tracklaying to keep hauling to a minimum, yet avoiding delay to the rail-laying train. This train was headed by a pioneer car, immediately behind which were usually four, but sometimes six, flat cars loaded with rail. The entire train was pushed ahead over the newly laid rails by a steam locomotive. The pioneer car and flat cars were provided with side runways equipped with rollers. Rails were rolled by hand, one at a time, from the flat cars into the runway, then pulled forward by a gasoline winch to the pioneer car. From there they were transferred ahead onto the ties by means of a hand-operated winch. The method of laying proved very efficient, as much as three miles of track being laid in one day, with an average of about two miles a day. No ballast was placed at the time of laying track, but the track was immediately given a running surface with dirt material to prevent the formation of surface kinks in the rails, and later it was lined and surfaced.

Air-operated track wrenches were used for bolt tightening and air hammers for driving track spikes.

Stations or sidings were built at eight points. Depots were built at Campo.

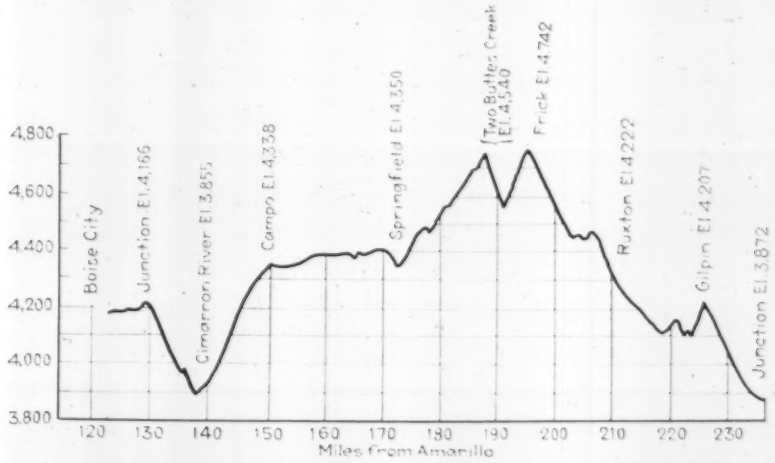


FIG. 3—GRADES on the new line have been kept below one per cent though it rises nearly 900 ft. in 40 miles to reach the high point near Frick.

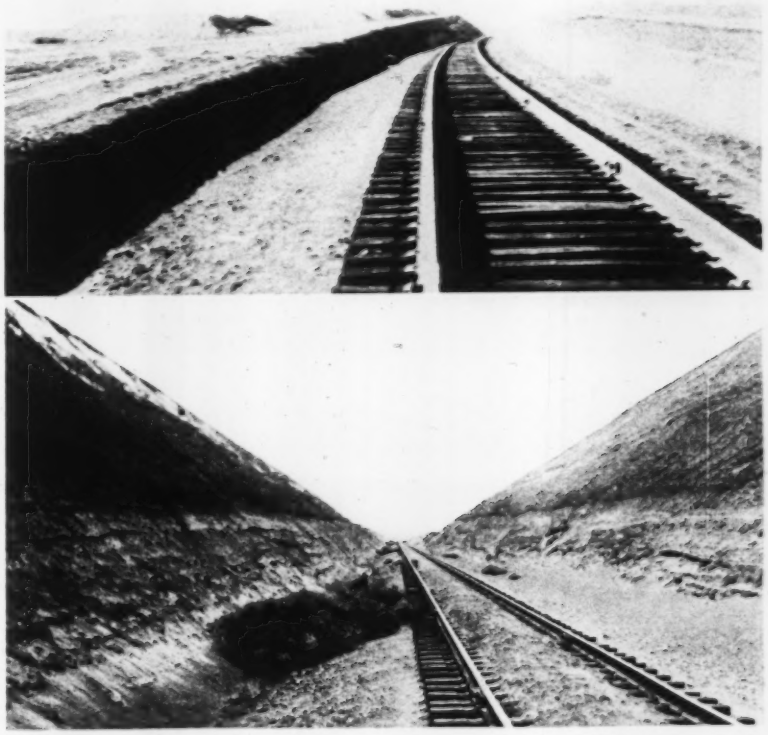


FIG. 4—GRADING was moderate for much of the distance traversed, but there were two sections in which cuts were deep and fills were high.

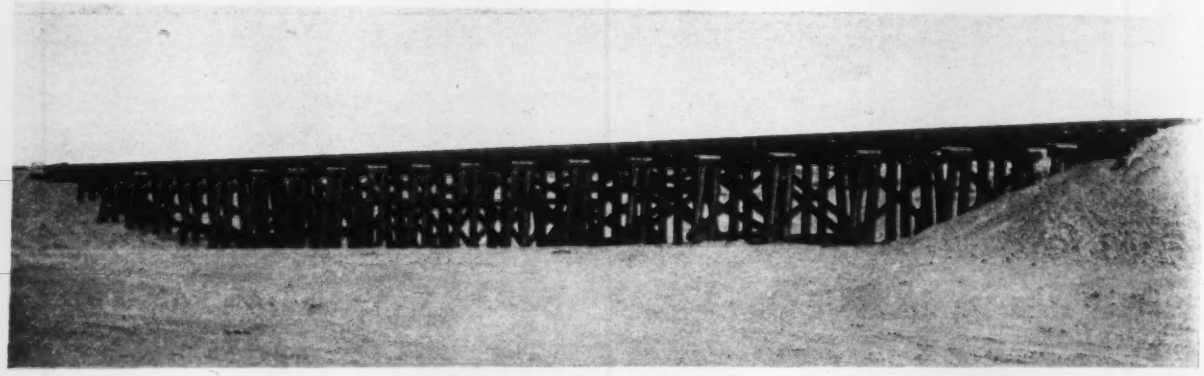


FIG. 5—TRESTLES are of creosoted timber, framed before treating, and the tops of the bents have been capped with metal to minimize maintenance.

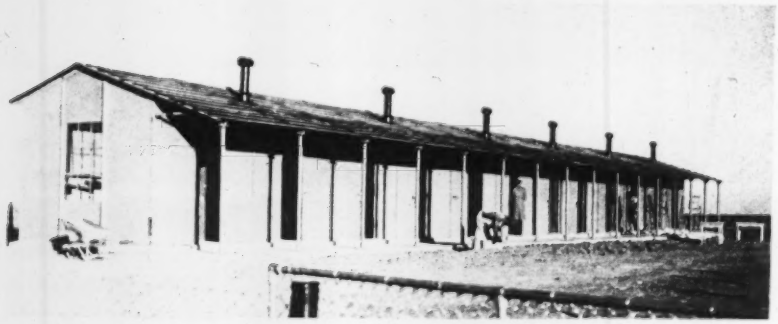


FIG. 6—A STEEL BUNK HOUSE was built at Bisonte as an experiment to develop the possibilities of this type of structure.

FIG. 7—MECHANIZATION was carried to the point of digging holes for fence posts with a tractor-mounted auger.

Frick and Ruxton, there being ample station facilities at Boise City and Springfield. An agent's cottage was constructed at Campo, while at Castaneda, Bisonte, Ramp and Gilpin, section headquarters were located, each consisting of a 5-room frame section house, a 12-room bunkhouse, a frame tool house, a well, windmill and tank. All bunkhouses were of standardized brick construction except at Bisonte, where a Truscon steel bunkhouse on concrete foundation was built for experimental purposes. All frame buildings were termite-proofed by the use of specially treated creosoted lumber below the floor line, and copper plates over the foundations.

At Castaneda, Campo, Frick and Ruxton, 20-car capacity stockyards were constructed. Water stations consisting of well, pumphouse and 100,000-gallon steel tanks were provided at Campo, Ramp and Ruxton. Wells at these points were 426, 401 and 175 ft. deep respectively. The water at Campo is satisfactory without special treatment, but at Ramp and Ruxton, the water is so hard that treatment is necessary before it can be used in locomotive boilers. The pumping equipment consists of turbine pumps direct-connected to diesel engines.

Fast construction

As stated previously, the fact that the line was accessible from three points on existing lines of railroad, as well as by automobile for its entire length, was largely responsible for the rapid completion of the work. Grading was started early in May at several points along the route. Because of fairly light work south of Las Animas, it was possible to begin laying track on that stretch in June. Completion of the Two Buttes Creek and the Cimarron River bridges was the critical feature upon which the completion of the entire line depended. Connections with existing tracks made it possible to lay track from Las Animas to Two Buttes Creek, from Boise City to the Cimarron crossing, then each way out of Springfield to the two stream crossings. The spans at the Cimarron River and at Two Buttes Creek were completed on Dec. 1 and 16 respectively, and tracklaying was completed immediately thereafter, thus providing through rail transportation to facilitate many of the final operations of construction. Buildings and water facilities were the last to be completed, and these were practically finished at the time the line was turned over for operation on Feb. 1.

Engineers and contractors

Engineering and construction work on the line was under the direction of G. W. Harris, chief engineer of the Santa Fe System at Chicago. In immediate charge of the work in the field was W. H. Rochester, construction engineer, with headquarters at Boise City. Resident engineers in charge of the four residencies on the line were A. W. Gobeli, J. G. West, A. E. Walker, and H. W. Smith.

The general contractor was the Sharp and Fellows Contracting Co. of Los Angeles, represented on the ground by J. P. Gilmore, general superintendent, with headquarters at Springfield. Much of the work was sub-contracted as follows: grading, Allhands and Davis; Barker Brothers; T. M. Page; McKnight Company, Robson and Conway. All concrete work (except the Cimarron River piers) was sublet to Allhands and Davis; fencing, box culverts, trestle bridge decks, riprapping and truck-hauling of creosoted lumber, W. R. Grinnel; tracklaying and surfacing, William A. Smith Construction Co.; buildings, T. A. Allen Construction Co.; well-drilling, J. F. Bauer. Pile-driving was done by the general contractor.

The writer is indebted to W. H. Rochester, T. T. Word and B. L. Pritchard for a large part of the factual information contained in this article.

Contractors' Insurance Costs Reduced By New Rating Plan

Compensation rates based on actual losses instead of average experience offer substantial savings in premiums in addition to usual credit for favorable accident record under standard rates

By J. W. Randall

Vice-president, Travelers Insurance Co., Hartford, Conn.

MOUNTING workmen's compensation insurance costs are of much concern to all interested in construction, and especially to contractors. Various means are being considered to check the ever-increasing premium rates that threaten to become a serious financial burden to the construction industry. One of the most promising of these is the retrospective rating plan, devised by the insurance carriers as a voluntary choice on the part of contractors to secure complete insurance protection at reduced cost. The plan is based on payment for actual losses only; the carrier being protected by a definite minimum premium, and the contractor by a maximum limit regardless of losses. Mr. Randall, an authority on the plan, has written the following article at the request of this journal. It is in part based on a talk he made on the subject before the Associated General Contractors Convention at San Antonio in February. —EDITOR.

COMPENSATION insurance rates are based upon experience data accumulated over a period of years. The rates applicable in 1937 are derived from losses and payrolls accumulated largely during the depression. Because wages were lower during the depression, the relation existing between compensation losses and payrolls then was different from that which exists today. It is not practical, however, to anticipate the trend of wages in rate making and the rates must be determined on the basis of actual experience. It is evident, however, that the lag in utilizing the experience in the usual experience rating plan does not give recognition to the trend of the individual risk experience as promptly as desired by either the insurance carrier or the assured.

As a means of meeting this situation the National Council on Compensation Insurance has promulgated the Compensation Retrospective Rating Plan. The distinctive feature of this plan is that the premium is determined retrospectively on the basis of the *actual* losses incurred instead of being fixed on the basis of *expected* losses. This method gives immediate recognition to the experience of the individual risk and affords relief to an employer qualifying for treatment under the plan.

The plan will be available to any risk with an annual estimated premium of $5,000 or more at standard rates. These are the rates which ordinarily would apply in determining the final premium for the risk if it were written on the customary guaranteed cost basis. The employer determines in advance whether to have his premium computed in accordance with the retrospective rating procedure or on the customary basis at present in effect.

How the plan works

Upon expiration of the policy the standard premium will be determined from audited payrolls and a certain percentage of this, known as the basic premium, will be set aside to cover underwriting expenses and a small contingency loading. The basic premium, independent of the loss experience of the risk, varies from 30 per cent for risks with standard premium from $5,000 to $25,000 down to 22.5 per cent for risks with standard premium of $150,000 or more. To this basic premium there will be added the actual losses incurred plus a loading to cover claim adjustment expense and taxes on this element of the final premium.

The retrospective premium is obtained by adding the actual incurred losses, increased for claim expenses and taxes, to the basic premium and is subject to minimum and maximum limits. Minimum premiums have been established to give the assured as much credit for favorable loss experience as is reasonably possible. The minimum premiums permit credits from the standard premium from 25 per cent for a $5,000 risk to 50 per cent for risks with standard premium of $75,000 or more. The maximum premium limitations were established to protect the employer against an abnormal increase because of unusually costly accidents. The maximum premiums grade downward from 75 per cent above the standard premium for a $5,000 risk to 25 per cent above for risks of $150,000 standard premium. These limitations have been established on a reasonable basis which will not inflict an unduly heavy penalty on the assured in the event that he has an adverse loss experience.

It should be emphasized that the present experience rating procedure will continue in effect to determine the initial rates for the risk even though such risk has elected the retrospective rating plan. This means that a risk which enjoys a credit modification from manual rates may secure under the retrospective rating plan an additional credit, which may be as high as 25 to 50 per cent dependent upon the size of the risk and its experience. Similarly, a risk which has an experience charge may through the operation of the retrospective plan not only eliminate such debit but even convert this into a credit modification.

The first computation of the retrospective premium will be made six months after the policy expires. Since there may be long term claims, it is provided that further premium adjustments will be made at dates 18 months and 30 months subsequent to termination of the policy period. These further premium computations are a guarantee to the assured that he will not be penalized for redundant estimates of open claims, while at the same time protecting the insurance carrier against inadequate estimates.

The plan contemplates application to the experience on an interstate basis. In other words, the experience in all states where retrospective rating is permitted will be combined in computing the premium. Under the usual plan interstate combination of experience is not permitted. The interstate feature of the plan is of particular importance to contractors, due to the fluctuation in the distribution of contractors' payrolls by state. Because

of the manner in which the usual experience rating plan operates, it often happens that a contractor, performing work in a new state or in one where his past operations were small, is required to pay manual rates even though such present operations may be of considerable size. Under the retrospective rating plan, however, this inequity will be overcome since the insurance premium will be adjusted on the basis of the contractor's actual losses and payrolls. Furthermore, by combining operations in all states it is possible to give lower rating values as established for a risk of the size indicated by the countrywide operations.

Accident prevention encouraged

The retrospective rating plan, by its immediate reflection premium-wise of favorable loss experience, provides a tangible and effective incentive for accident prevention work. Insurance carriers which have applied the principle of retrospective rating have witnessed a pronounced improvement in the experience of risks after they were placed on this basis. There are undoubtedly many contracting risks throughout the country which will benefit considerably if they elect the retrospective rating basis of premium adjustment. The Travelers tested this plan on a representative group of large contracting risks during a period when compensation was not producing good experience. Therefore, the results may be considered to be conservative indications of how the plan will operate in practice. The total premium at standard rates for this group of risks amounted to $1,510,731 whereas the tests indicate that if retrospective rating had been applied there would have been a premium saving of $187,682 or 12.4 per cent.

There were, of course, risks with adverse experience which would have required debit premium adjustments under the plan. However, it is interesting to note that of the total of 29 risks included in the tests there were but four where a debit rating would have been required in more than one year of the experience period.

A further consideration is that retrospective rating for compensation risks will broaden the insurance market. Under the customary guaranteed cost basis of premium computation the contractor often experiences difficulty in securing coverage at standard rates due to the unwillingness of the insurance carrier to write such operations without additional protection. With retrospective rating the contractor may elect this plan which will give him the benefit of a premium based upon his actual loss experience during the policy period.

The advantages of retrospective rating should more than offset the objection which has been raised in certain quarters, that contracting risks must know in advance their exact insurance premiums based upon estimated payrolls for a given operation. The premium savings would, on the average, be sufficient to warrant adapting accounting procedure to the revised basis of premium determination.

A contractor whose compensation premium is less than $5,000 annually should likewise be interested in this proposal, not only because the small contractor of today may become the large contractor of tomorrow, but also because the insurance rates which he pays are based upon the combined experience of all risks in his classification. Since retrospective rating will improve the state-wide experience, this should have a favorable effect on classification rates for all risks in the state.

Plan not yet nation-wide

So far the plan has been approved for use in sixteen jurisdictions:—Ala., Conn., D. C., Idaho, Ill., Ind., Iowa, Md., Mass., Mont., Neb., N. M., Okla., R. I., S. D., and Vt. In most of the other states approval of the plan has been postponed, pending further study by the insurance authorities. It is expected that a decision will be given in the important states of New York and New Jersey in the near future.

An important contributing factor in the delay in securing official approval of the retrospective rating plan in certain states is the apathetic attitude of those for whose benefit the plan has primarily been designed—the employers. Undoubtedly, if the insurance authorities realized that there was a real and active demand on the part of employers for such a plan, official consideration of the merits of the proposal would be materially expedited.

Further details of the application of the plan for any state in which a contractor has operations may be obtained from the National Council on Compensation Insurance, 151 Fifth Ave., New York City, or from the National Bureau of Casualty and Surety Underwriters, One Park Ave., New York City. On the basis of such information, it would be a simple matter for the individual contractor to determine whether or not the application of retrospective rating to his operations would have produced a reduction or an increase in his compensation premiums over a period of several years. It is urged that such a study be made by contractors whose operations are of sufficient size to qualify for treatment under the plan and that they familiarize themselves with the status of the adoption of the plan in the states in which they operate.

Retrospective rating should have a particular appeal to contractors. It is a cost-plus plan within the limitations of the minimum and maximum premiums, offering an opportunity for most substantial savings in the cost of insurance without placing an unreasonable penalty on poor experience. It is optional and not compulsory and therefore affords the opportunity to select either a guaranteed-cost plan or a cost-plus plan, whichever in the buyer's judgment is best adapted to meet his requirements.

Some Welding Problems For the Future

IN AN INTRODUCTION to a supplement on welding, published as a part of the Oct. 23, 1936, issue of *The Engineer* (London), Otto Bondy discusses some of the achievements and prospects of welding. A growing confidence in welded joints will in Mr. Bondy's opinion reduce the present demand for unusual precautionary testing of welds. In a table he lists the permissable working stresses in welded butt joints in various countries; butt welds were used for illustrating purposes "because their permissible working stresses can be considered as a sort of confidence factor, giving a good indication of the practical experience with welded structures in the various countries." In Great Britain, Germany, Switzerland and Belgium, the butt weld is considered to be worth 100 per cent in compression (as compared with the parent metal) but the figures for tension do not yet get up to more than 85 per cent in Great Britain and 89 per cent in America; American stresses in compression are taken at 89 per cent of the parent metal.

Among the subjects for future research listed by Mr. Bondy is fatigue in welded joints, so that welding may be more generally permitted for truss bridges. He points out that in Germany there are 200 all-welded plate girder railway bridges, but no truss bridges. Another problem is "to calculate shrinkage stresses so as to be able to turn their disadvantages into an advantage, counteracting the working stresses under live loads." Then there are several problems connected with testing; for example, it would be useful if X-ray tests could be made to indicate the internal conditions of stress within a welded joint. New developments are still to be expected by introducing new rolled sections for welded structures, according to Mr. Bondy. He cites the fact that 16,000 tons of "bulged profile" plates have been rolled in Germany up to the beginning of this year and used extensively for welded plate girder bridges.

A Record Size Bascule

Outer Drive crossing of Chicago River is a double leaf structure, 264 ft. between trunnions and 108 ft. wide, designed for double-deck service

FIG. 1—TEST OPERATION of the double-leaf bascule on the new Outer Drive link in Chicago. The tower framing at the four corners will be enclosed in limestone to form decorative pylons, which will also contain the operators' houses.

THE KEY STRUCTURE of the Outer Drive link that is being built in Chicago to join the south and north side lakefront boulevard systems is a double-leaf bascule over the mouth of the Chicago River. If a lower deck, for which provision has been made in the design, is added at some future time, each leaf will weigh 6,240 tons and be heavier than any bascule now in existence. As initially built, with only an upper deck, the leaf weight is 4,364 tons, which is less than the double-deck Michigan Ave. bridge upstream from it. At the same time the Outer Drive Bridge is 108 ft. wide and 264 ft. long between trunnions, which causes it to rival, if not exceed in these respects, any bascule bridge in the world. In both its design and construction it is a notable structure.

The general features of the Outer Drive link and its importance in helping to solve Chicago's traffic problem were outlined by Hugh E. Young, chief engineer of the Chicago Plan Commission in *ENR* April 15, 1936, p. 546. It will be recalled that it provides a long-planned connection between the south side lakefront boulevards which terminate in Grant Park and the north side boulevards that traverse Lincoln Park, and which now are joined only by the Michigan Ave. bridge. On the south side of the river a steel viaduct, 2500 ft. long, serves as an approach to the bascule, and in addition there is a 1500 ft. viaduct connection to Michigan Ave. along Randolph St. The north side approach is also viaduct, 1200 ft. long, supplemented by a 100-ft. single-leaf bascule over the Michigan Canal. These viaducts are 140 ft. wide, and provide a 100-ft. roadway and wide sidewalks. Some of the interesting phases of this approach work, such as the special methods used in sinking the circular piers 85 to 100 ft. to rock and the design and construction of viaducts, which are two-story rigid-frame three-column bents, will be covered in subsequent articles.

The history of the bascule bridge dates back to July 25, 1929, when a contract was let for its design to the Strauss Engineering Corp. Foundations were built and the steel fabricated before the depression caused the work to be shut down. In 1935, work was begun on the delayed erection contract, and the bridge is now practically complete, furnishing two 38-ft. roadways and two 24-ft. sidewalks. The navigation clearance in closed position is 24 ft., and the clear span between counterweight pits is 220 ft.

The Outer Drive Bridge is of the so-called fixed-counterweight type. Each leaf consists of four parallel trusses, 28½ ft. on centers, located entirely below the upper-level roadway. Each truss (Fig. 2) is made up of 7 panels, 15 ft. 10 in. in length, and one panel adjacent to the trunnion of 18 ft. 2 in. Behind the trunnion are three panels of irregular length which support the counterweights beneath the deck. The upper deck floorbeams, built-up members 32 in. deep, connect the trusses at the panel points along the upper chord. Stringers spanning between the floorbeams, with upper flanges flush, are spaced 2 ft. 8½ in. apart. The trusses are held rigid by an upper and lower lateral bracing system. The deck is made up of steel-grid units filled with light-weight concrete and welded to the deck framing.

Each of the four trusses of a leaf is supported on a steel shaft, operating in a pair of trunnion bearings. These in turn are carried on two 80-ton cross girders spanning between pedestals on the walls of the counterweight pit and steel columns under the inside trusses (Fig. 4). Each column extends through the pit floor to a bearing on an 11-ft. diameter caisson, while a 12-ft. diameter caisson is used beneath each sidewall under the pedestals. Silicon steel is used for the trusses, the supporting cross girders and the trunnion posts. The floor system is carbon steel.

Foundations

The counterweight pits themselves are structures of considerable magnitude, and their location in 25 ft. of water complicated design and construction. Each pit (Figs. 2 and 5) is a concrete box 104½ x 68 ft. and 40 ft.

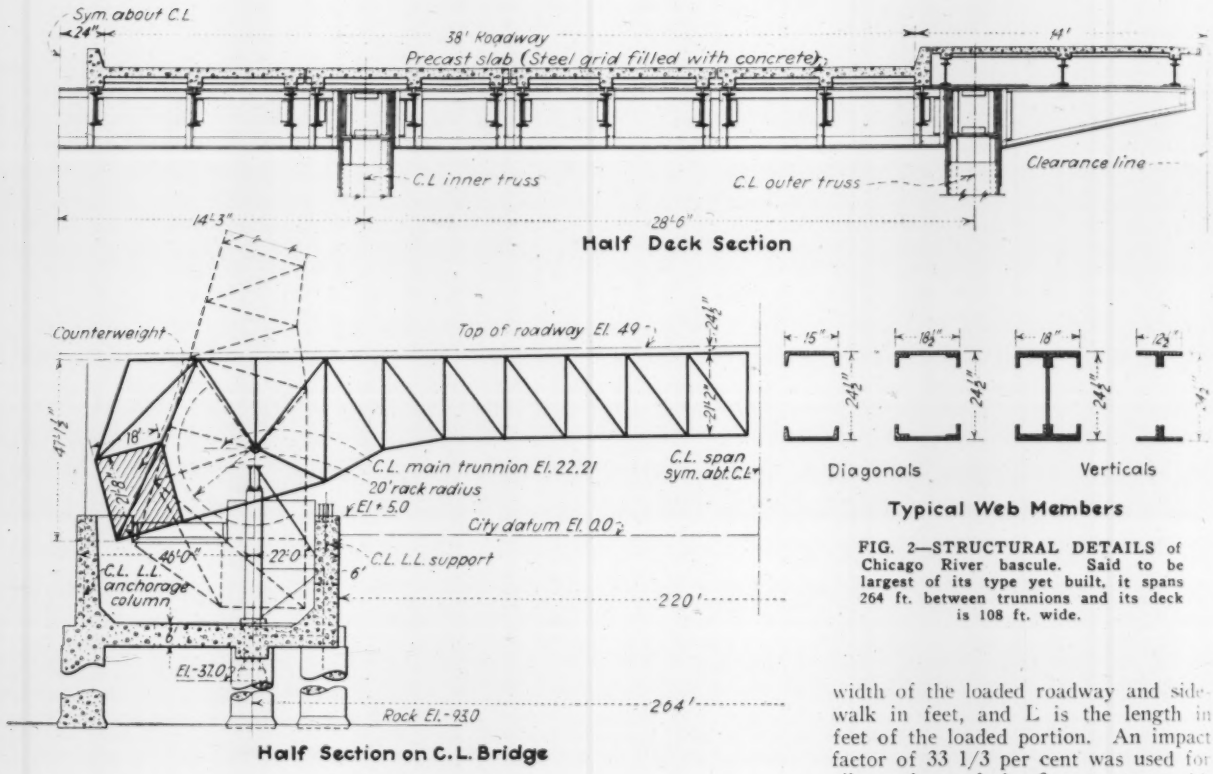


FIG. 2—STRUCTURAL DETAILS of Chicago River bascule. Said to be largest of its type yet built, it spans 264 ft. between trunnions and its deck is 108 ft. wide.

deep, supported by three circular piers along its back edge and by four circular piers along its front edge. In addition the four piers, which are set 22 ft. shoreward of the front face of the pit and serve as foundations for the trunnion girders, also aid in supporting the box. The piers range in diameter from 4½ to 12 ft. and are founded on rock at depths of 60 to 70 ft. below the bottom of the pits.

The several parts of the counterweight pit are designed for a variety of conditions of horizontal and vertical loading. Thus, the river wall is designed to resist full hydrostatic head on the river side and a 560,000 lb. collision load from a boat. Full hydrostatic head on the inside of the wall only was also considered for conditions during construction. The several combinations of vertical loads include buoyancy on the pit floor.

The river wall was designed both as a continuous beam over four supports and as a vertical cantilever beam for bending due to horizontal loads. Similar design was used for the rear wall (except that it is continuous over three instead of four supports). The side walls were designed as beams with ends fixed at the river and rear walls, as beams continuous over three supports and as vertical cantilevers fixed at the pit floor. The pit floor was designed as a slab continuous over three supports —the river wall, the transverse girder on the centerline of the main trunnion sub-piers and the rear wall. The sub-piers were designed as fixed in the clay at El. —58.5 and at the floor. For load combinations including wind and also water inside of the pit, 25 per cent increase in the unit stresses was allowed, while for the load combination including boat collision, the increase was 50 per cent. The allowable unit stresses were 16,000 lb. per sq.in. for steel and 750 lb. per sq.in. for concrete ($n = 15$).

The counterweight pit and its supporting piers were built in an open cofferdam of single-wall type made of deep-arch, interlocking steel sheetpiles, and with internal timber bracing supported vertically by timber piles as well as by vertical and diagonal bracing between the various tiers. The concrete pit floor, involving 1500 cu.yd. of concrete, was placed in a single continuous operation covering 68 hr.

Bascule bridge design

In designing the bascule leaves the dead loads considered included a lightweight slab on the upper roadway and sidewalk deck, and timber roadway and sidewalks on the future lower level. Live loads used in the design were 125 lb. per sq.ft. on all roadway areas; 100 lb. per sq.ft. on all sidewalk areas; 4000 lb. per lin. ft. of street car track on the lower deck; a concentrated load of two 24-ton trucks abreast for the upper deck; a 50-ton trailer truck as an alternate to the two 24-ton trucks on the lower deck roadway in the center and west bays and a 105-ton rail car in the east bay.

The impact coefficient for the trusses was determined by the formula $100 \div (NL + 300)$ where N is 1/10 the width of the loaded roadway and sidewalk in feet, and L is the length in feet of the loaded portion. An impact factor of 33 1/3 per cent was used for all members of the floor system, with the following exceptions made when the wheels are at the roadway breaks: railroad stringers, 100 per cent; roadway stringers, 75 per cent; floorbeams 50 per cent.

In addition to the above dead and live loads, vibration and lateral and longitudinal forces were considered. To provide for the effects of vibration when the bridge is open, the stresses in the members due to the dead loads of the movable leaf were increased 20 per cent; the masonry substructure and the members completely imbedded in it were not subject to this provision. The lateral force was assumed to result from a moving uniform load of 150 lb. per lin. ft. applied at the floor level, plus a moving load of 25 lb. per sq.ft. on the full vertical projection of the floor and one truss, and on 50 per cent of the vertical projection of the three remaining trusses; or an alternate concentrated load of 240,000 lb. applied at the second panel point forward of the river pier bearing. With the bridge open, a longitudinal wind force of 20 lb. per sq.ft. on the vertical projection of the exposed area was considered. With the bridge closed, a longitudinal traction force was used consisting of 10 per cent of the live load on the structure, taken as acting at 4 ft. above the floor.

In the design of the trusses, upper and lower deck loads were considered simultaneous, and both outside trusses were made alike and both inside trusses made alike, despite the disparity in loads. The truss reactions were determined for five different conditions of loading: dead

Chicago Aerial Survey Photo

FIG. 3—KEY STRUCTURE in the Outer Drive improvement is the bridge over the mouth of the Chicago River. In the foreground of this air view the filled approach rises from Grant Park to the Field Blvd. viaduct which connects at the riverbank with the Wacker Drive viaduct at right angles to it. North of the river is the Michigan Canal crossed by a single-leaf bascule and then the viaduct cuts through an existing building. In the left foreground the Randolph St. viaduct provides a connection with Michigan Ave.

loads only, bridge closed; live loads only, bridge closed; dead and live loads, bridge closed; dead load, bridge open; and wind load, bridge open. Design stresses in the trusses due to these several loading conditions were then determined for the bridge in both the open and closed positions. The maximum stress in the closed position was determined by a combination of dead load, live load, impact and reversal; in the open position, by combining dead load, vibration, wind, and reversal. Where wind was considered, the allowable stresses were increased 25 per cent. The fact that the maximum stress in a member may occur at any point of partial opening of the bridge was also taken into account in the design. In the specifications "Reversal" is covered by the following:

> Whenever the live and dead load stresses are of opposite sign, only two-thirds of the dead load stress is considered to be effective in counteracting the live load stress. When reversal occurs during the passage of loads, the net tensile and compressive stresses are determined in accordance with the above provisions. Each of these, then, is increased by 50 per cent of the smaller. When reversal occurs during the operation of the bridge, 25 per cent is used instead of 50 per cent. Connections in all cases are proportioned for the sum of the net tensile and compressive stresses.

Machinery for bridge operation

The operating equipment for the Outer Drive bascule is in keeping with the size and importance of the structure. Safety and dependability were first considerations, and brakes, locks and current supply were planned with these objectives in mind. Direct current at 550 volts for bridge operation will be supplied from the cables feeding the Michigan Ave. bridge upstream. Submarine cables will be installed to connect the two ends of the bridge. Alternating current for street lighting will come from two separate sources. Operators will be stationed in stone-faced bridge houses, 24 x 28 ft. in plan, located at each corner of the bridge.

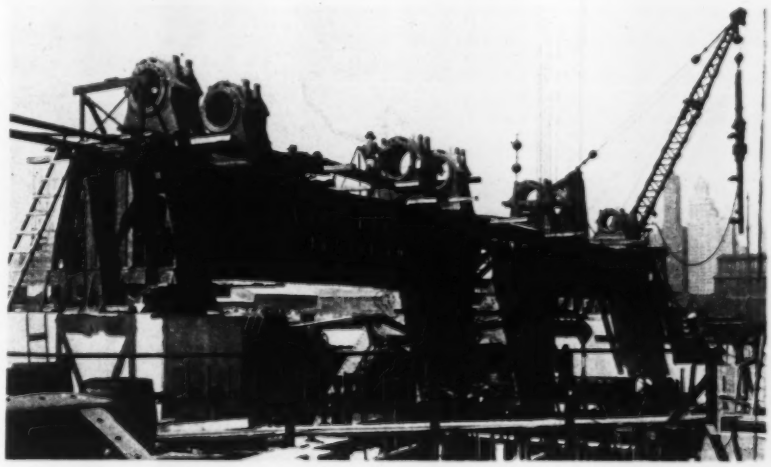


FIG. 4—SETTING TRUNNION BEARINGS for one of the bascule leaves. The two trunnion girders each weigh 80 tons and span between the walls of the counterweight pit and columns under the inside trusses.

FIG. 5—HUGE PIT for south counterweight of Chicago River bascule. It is supported on eleven circular piers and, being located offshore, is designed against full hydrostatic head and uplift.

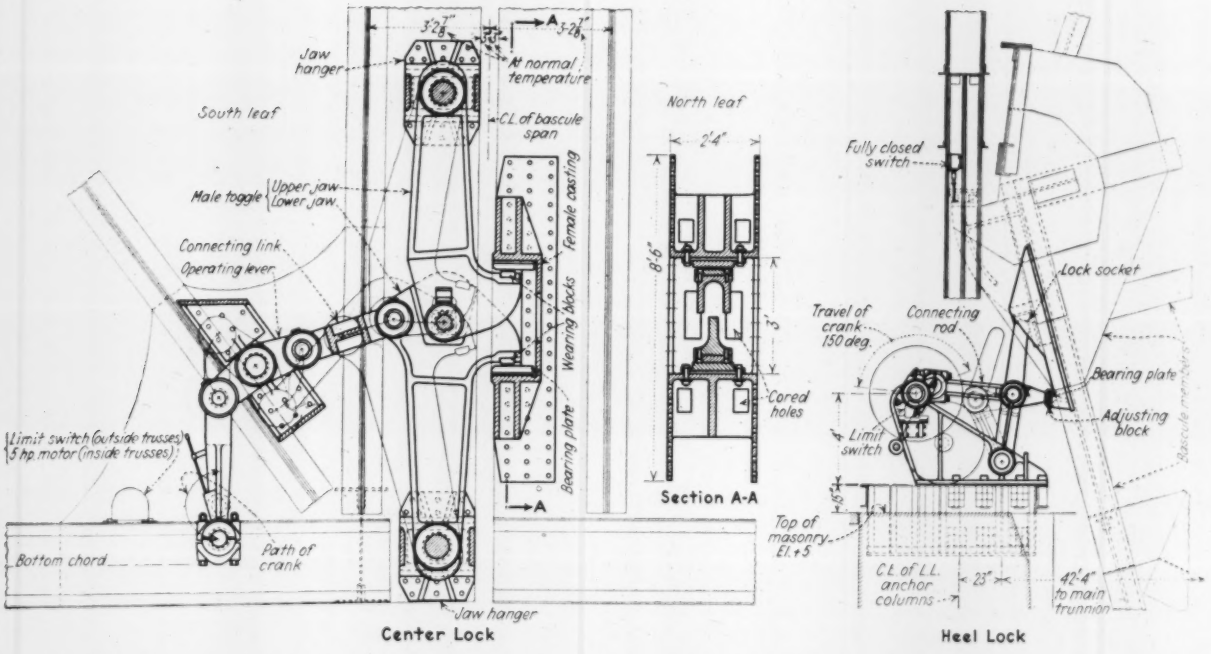


FIG. 6—LOCK DETAILS used at the center and rear of the leaves of the Outer Drive bascule.

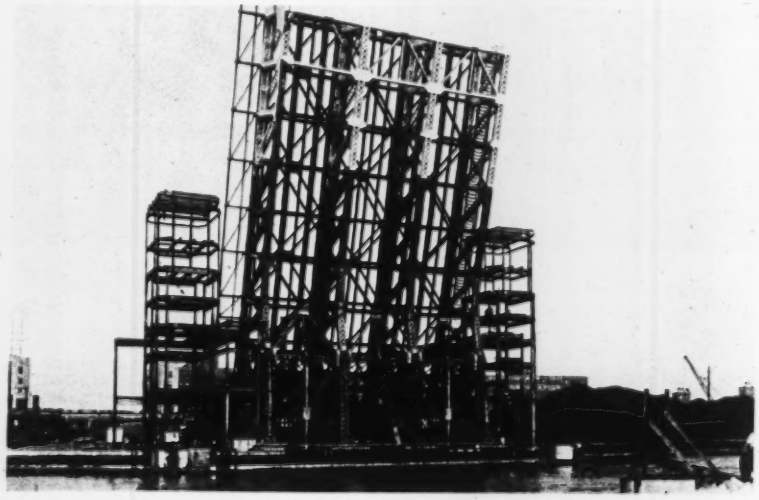


FIG. 7—PAINTING A LEAF of the Outer bascule following the topping-out of the steel which was erected with the leaf in the open position.

Each leaf is to be operated by two sets of gear trains, consisting of four sets of gear reductions. Each gear train is connected to two 100-hp. main operating motors, only one of which is to be used at a time. The time required for opening or closing the bridge against a 28-m.p.h. wind is stated to be 57.6 sec., of which 10 sec. is for acceleration and 2.86 sec. for deceleration. The main operating racks are bolted to the underside of the outside trusses, the pitch radius being 20 ft. The operating pinion, with a pitch diameter of 40 in., is mounted on a shaft of the gear train.

The four trunnions are of drop-forged steel and have a 10-in. dia. hole bored the entire length. The inside trunnions are 34 in. in diameter at the bearings and carry a load of 4,411,000 lb. each, of which 3,673,000 lb. is dead load, 734,000 lb. is vibration or impact (20 per cent of the dead load) and 185,000 lb. is the load from a 20-lb. wind. The unit stress is 11,100 lb. per sq.in. under combined load. The outside trunnions, 27½ in. in dia., carry a load of 3,337,000 lb., and are subjected to a unit stress of 15,800 lb. per sq.in.

Heavy locking devices are provided at the center of the bridge and at the heel of each leaf, to hold the bridge rigid in its closed position (Fig. 6). The center lock in addition to holding the leaves together in their closed position, also transmits live load shear from one leaf to the other. This center lock consists of a set of four female castings bolted to the river end of one leaf, and a second set of four male units bolted to the river end of the other leaf, all castings being on the centerlines of the trusses. The male unit consists of two castings forming a toggle. Fingers, cast integral with the toggle castings at the center, engage the female casting and, since the loads are on dead center, the device is self-locking. The four male units are connected by shafting, and are operated by 5-hp. motors set on the bottom chords of the inner trusses.

Heel or rear locks are necessary to prevent the leaves from opening when live loads pass over the part of the bridge between the trunnions and the rear break in the floor. Each leaf is provided with two pairs of rear locks, each pair being placed between the inside and outside trusses. The four locks of a leaf are connected by shafting, and operation is by means of two 15-hp. motors set either side of the centerline of the bridge.

Erecting the bascule

Interest in the erection operations on the Chicago River bascule span centers principally in the equipment layout used by the contractor, Ketler-Elliott Co. Each leaf was assembled in its open position, so that the erection operations on each side of the river were entirely separate. Main items of equipment for each set-up were an unusually heavy and long-boom stiffleg derrick and an

FIG. 8—THE LIGHT WEIGHT DECK is made up of steel grid units filled with concrete at a nearby plant and welded to the floorbeams and stringers.

electrically-operated concrete mixer. In addition a derrick on a reinforced concrete scow was used to transfer materials and equipment across the river, while on either side a 50-ton locomotive crane was used to unload material and move it within reach of the stiff-legs. The compressor—a 300-cu.ft. unit driven by a 75-hp. motor—was located on the south side of the river, and connected with north side operations by submarine cables.

The stiff-legs used were among the largest in the Chicago region. Reeved with 7/8-in cable, they were required to lift loads as heavy as 80 tons, which is the weight of each of the four trunnion girders. The boom lengths were varied from 80 to 160 ft. during the progress of the work. Both derricks were supported on piling, that for the south derrick being originally located in 30 ft. of water. This derrick was anchored against uplift by lashing it to the piling while the north derrick was held down by precast concrete blocks later used to adjust the bridge counterweights.

As steel erection progressed, the counterweight was poured to maintain balance. Two types of concrete were used, one a conventional product weighing 143 to 150 lb. per cu.ft. and the other a mixture of plain concrete and steel punchings weighing 225 lb. per cu.ft. All material going into the mixers was carefully weighed.

After the leaves were topped out, they were lowered, in order that the deck units—steel grids filled with concrete—could be set by the derrick scow. These units were welded to the floor steel. Installation of deck alternated with pouring of additional concrete in the counterweights, to keep the leaves balanced. In the alternating operations an attempt was made to limit the overload to an amount indicated by a 350 amp. reading at 550 volts in operating the leaf.

Personnel

The layout of the Outer Drive Improvement was developed by the Chicago Plan Commission. Subsequently, Hugh E. Young, chief engineer of the Chicago Plan Commission served as consulting engineer for the former Lincoln Park Commissioners on the work north of the Chicago River, and for the South Park Commissioners on the bascule bridge over the river. The initial design work south of the river, except for the Randolph St. viaduct, was carried out under the direction of George T. Donoghue, general superintendent, and Linn White, chief engineer, South Park Commissioners. The bascule bridges and bridge plazas were designed by the Strauss Engineering Corp., Chicago.

The final revision of the plans and the preparation of specifications for the river dock, south approach, Field Blvd. viaduct and the Wacker Drive viaduct, as well as all construction operations that have gone on since 1934 have been under the general direction of George T. Donoghue, general superintendent, Ralph H. Burke, chief engineer, W. I. Bell, asst. general superintendent and Robert A. Black, asst. chief engineer, of the Chicago Park District. The Randolph St. viaduct was designed by the Illinois Central R.R. and the Michigan Central R.R. Frank A. Randall, consulting bridge engineer, is in charge of construction operations in the field for the Chicago Park District. D. R. Kennicott, state director, and G. L. Rounds, state engineer inspector, represent the Public Works Administration on the project.

Folding Ladder Inside Pipe Holds Scaffold for Welders

LARGE STEEL PIPE which has to be welded on the inside while the pipe is in the trench, requires some means for making the seams conveniently accessible to the welder. This problem has been solved on the 11½-ft. distribution system pipes laid by the Metropolitan Water District of Southern California, by the use of folding ladders which open up into semi-circular shape of a diameter just fitting the pipe interior. Planks are laid transverse to the pipe, resting on rungs of opposite sides of the ladder. Thus convenient supports are provided which can be moved horizontally within the limits of the rung length. On these supports the welder can sit or stand as may be best suited to his work.

There are five segments of the ladder connected by hinges and when the planks are lifted off preparatory to moving, the sections are folded up one upon another and in the collapsed condition can be carried ahead conveniently to the next joint. The upright post has nothing to do with the scaffolding; it is a strut which holds the sections in the desired shape at the joint after jacks are used to force the section into circular shape.

A COLLAPSIBLE LADDER serves as a convenient support for welders in an 11½-ft. steel pipe.

Squeeze Test for Integrity Of Soil Samples

A field indication and a laboratory check of soil disturbance in taking and shipping samples of undisturbed soil

By Donald M. Burmister
Columbia University, New York, N. Y.

IN LABORATORY study of undisturbed soil there is always chance of disturbance in taking the sample and in transferring it to the laboratory. It is natural that some samples will suffer more disturbance than others, and naturally also the value of the laboratory determinations will be increased if some qualitative method is had for selecting the least disturbed samples for testing and discarding the others. Such a method, a form of squeeze test, is discussed here.

It has been generally assumed that, because approved soil samplers and approved methods of sampling are used, an undisturbed sample is obtained and that it reaches the laboratory in good condition for the physical tests. Too often quality of sample has been sacrificed for speed in driving a boring. While there is no such thing as a truly undisturbed sample, there are definitely degrees of goodness.

A simple squeeze test is suggested for determining something of the degree of goodness of the sample on the site. It is then highly desirable to follow the sample up with control tests in the laboratory to determine if any serious changes in the condition of the sample have occurred subsequently.

How test is made

The squeeze test is similar in principle to the two-dimensional squeeze test discussed by Dr. Jurgenson in his paper on Shearing Resistance of Soils (Boston Society of Civil Engineers, July 1934, Vol. XXII, No. 3), and is made by squeezing a specimen of clay having a cross sectional area of 2 sq.cm. (diameter, 1.595 cm.) and a height of 1 cm. The device is illustrated in Fig. 1.

A sample of the undisturbed clay is taken by pushing the cutting tube *A* with the plunger *B* set in the upper slot *a* into a slice of the underground clay a little over 1 cm. thick. A spatula is inserted under the cutting tube to lift it free. After the excess clay has been trimmed off and the tube wiped clean, it is inserted in the upper plate *C* and locked in position. The specimen is then forced out of the cutting tube by the plunger, which is then locked in the lower slot *b*. The upper plate with the clay specimen sticking to it is placed in position over the guide pins on the base *D*.

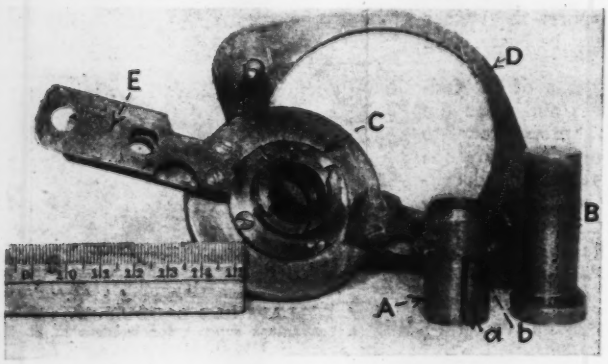
The test load is 2 kg. and is applied by the calibrated springs *E* using the thumb tips, which are placed over the holes in the ends of the springs. The springs are depressed slowly and evenly until the thumb tips feel the button on the end of the bar below, giving a sensitive load-end point. These springs may be readily calibrated for the 2-kg. load (4.4 lb.) by placing the upper plate on the platform of a spring scale, depressing the springs, and filing notches until the springs have the desired resilience. For very stiff clays the springs should be calibrated for a 5-kg. test load.

The whole device is lifted, turned over and the final diameter of the squeezed clay specimen is measured in two places at right angles. The final diameter in centimeters of the squeeze test is now used as a measure of shear strength. The results of a test on a typical plastic clay, having a high water content is illustrated in Fig. 2. Tests on both the undisturbed and remolded clay must be made, because it is the relation between these two tests which is important.

The tests bring out clearly the marked effect of disturbance of any kind upon the natural clay. An increase in diameter of the remolded specimen over that of the undisturbed specimen represents a marked reduction in shear strength. This fact is given greater significance when the results of the squeeze test are converted into approximate shear strength by means of the experimental curve, Fig. 3. For example, the spread between 2.7 cm. for the undisturbed and 4.5 cm. for the remolded material represents a reduction of shear strength from 0.018 tons per sq.ft. to 0.015 tons per sq.ft.

Structure is one of the most important physical properties of clays because it gives a shear and compressive strength far in excess of that which would be expected from moisture content alone. The squeeze test result on the undisturbed clay is determined almost entirely by the structure of the clay, while the result on the remolded material is largely determined by moisture content. Therefore the results of the squeeze test afford a simple and satisfactory measure of structure.

It is interesting to note that the experimental curve of the results of the squeeze test versus moisture content shown in Fig. 4 is a linear relationship for the remolded material. This is most fortunate, because if the results of the remolded squeeze test are known for any two moisture contents, a consistency line may be drawn. This is of considerable importance because it makes it possible to detect changes in moisture content by means of the test on remolded material. The effect of variations in the character of the material is to change the slope and the position of the consistency line, which are directly related to the liquid and plastic limits of the material. In fact, these two limits may be interpolated from the consistency line for plastic soils and therefore represent certain



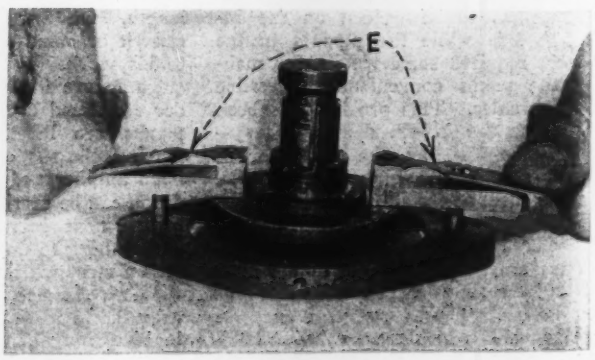


FIG. 1—SQUEEZE TEST DEVICE for selecting least-disturbed soil samples cut from undisturbed soils for laboratory determination of mechanical properties.

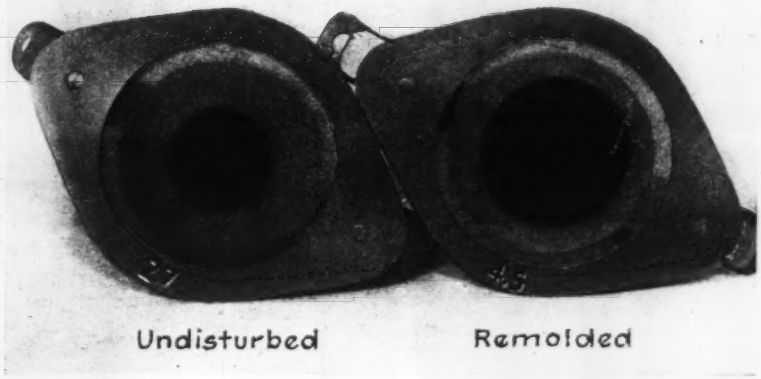


FIG. 2—EFFECT OF SQUEEZE test on undisturbed and remolded samples of the same clay soil.

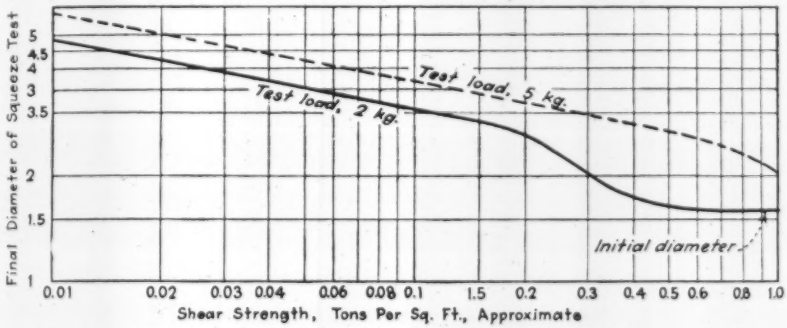


FIG. 3—RELATION between the final diameter obtained by the squeeze test and the ultimate shear strength of the soil.

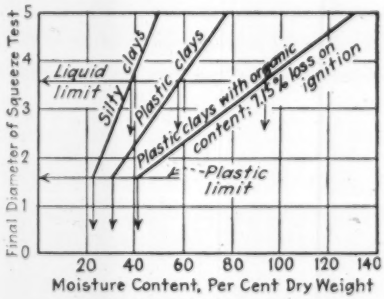

Final Diameter of Squeeze Test
Liquid limit
Silty clays
Plastic clays
Plastic clays with organic content; 7.5% loss on ignition
Plastic limit
Moisture Content, Per Cent Dry Weight

FIG. 4—RELATION between the final diameter of the squeeze test and moisture content for remolded clays.

definite shear strengths. Non-plastic silts cause the plunger to stick so that the test can not be made for these soils. Therefore, this is a means of differentiating more distinctly between non-plastic silts and plastic soils.

These two curves now make possible not only a very practical use of the squeeze test as a laboratory- and field-control test, but also provides a preliminary estimate of the shear strength of the material. The purpose of the squeeze test in the field is to furnish the sampling inspector certain information on the spot, so that he may judge something of the degree of goodness of the sample.

To expedite the preparation of the sample and still make it possible to make the field control test, trimmings from the top and bottom of the sample should be placed temporarily in a container with a tight cover, in which some moist cotton is placed to prevent loss of moisture. After the sample tube is sealed and marked, both the undisturbed and remolded squeeze tests can be made upon the trimmings at the inspector's leisure. Care should be taken to identify which is the top and bottom trimming and to keep the material covered while making the test. The results of the squeeze test should be marked on the identification table of each sample for laboratory reference and for checking.

If the sample is in good condition and representative, the values for the top and bottom should be identical with a considerable spread between the results for the undisturbed and remolded tests. The amount of spread that one might expect can be determined after taking a few samples in a given area. Now variations in the results may be due either to disturbance during sampling, or to actual variations in the character of the material within the sample length. If the squeeze test results are appreciably different in the laboratory from those marked on the sample, then there has been either loss of moisture, or further internal disturbance. This information is necessary for selecting the most representative and least disturbed sample for the shear and consolidation tests.

Conclusions

The following conclusions on the squeeze test are emphasized:

1. The squeeze test may be used as a field-control test to determine the goodness of the sample and as a check on subsequent changes in its condition.
2. The results of the squeeze test may be used in the laboratory as a basis for selecting those samples which will give the most reliable results for the physical tests.
3. The squeeze test gives a preliminary estimate of the shear strength of all samples and a measure of the variations in the character of the sample or the degree of disturbance.

The writer is greatly indebted to Moran, Proctor & Freeman, consulting engineers, for the opportunity to make the soil investigations in which this squeeze test was developed.

Mosquitoes Imported by Airplanes

THE QUICK PASSAGE of airplanes from South American countries to the United States and the specific possibility that mosquitos infected with yellow fever may be transported in such carriers make it necessary for quarantine officers in domestic ports to keep a sharp lookout for dangerous insect visitors, according to *Public Health Reports*, (Vol. 52, No. 14) issued by the U. S. Treasury Department. That insects are conveyed in airplanes is now recognized as an actuality and a source of potential danger.

During November 1936, states the report, 69 inspections were made by officers of the Public Health Service at Miami, Fla., to determine the presence of mosquitoes in airplanes arriving from South American ports. In 45 instances no insects were found. However, during the course of 24 other inspections 53 insects were captured while 1 escaped. The maximum number of mosquitoes found during a single inspection was 3, of which number 2 were dead.

While no yellow-fever mosquitoes were discovered on these inspections, the report stated that such species might easily be brought into this country by airplanes unless adequate measures are observed to prevent their importation.

Golden Gate Bridge Scaffold

Study of accident by engineers of bridge district results in conclusion that hangers failed through overstress of aluminum side castings

TESTS of two of the hangers used to support the form-stripping scaffold that fell from the Golden Gate Bridge at San Francisco (*ENR*, March 11, 1937, p. 377) have been completed at the University of California laboratories at the instigation of the engineers of the bridge district. The results of these tests, as well as some design computations, are embodied in a report by Clifford E. Paine, principal assistant engineer, which carries the conclusions that the weakest parts of the hangers are the cast aluminum side plates of the trolley; that in normal operation each hanger had to sustain a load of 10,000 lb. plus 50 per cent impact or 15,000 lb., which was approximately the ultimate strength of the hanger tested; that considering the loads to be carried and the manner of loading, the hangers should have been designed for a 40,000 lb. ultimate load. At the same time, Mr. Paine states that, in his opinion, "the contractor earnestly endeavored to furnish in the stripping platform which failed a superior piece of equipment without regard to cost, and whatever deficiencies there may be in the design are present only because of errors in judgment and obviously not because of any attempt to skimp the design."

As shown in the accompanying illustrations of the test set-up, the hangers are made of steel hooks, which engage the bridge cross girders, and a suspended trolley consisting of two cast aluminum side plates joined together on a pin at the top. Each side plate carries two rollers supported on cantilever pins, and these rollers supported the trolley beams of the scaffold. It will be recalled that the scaffold platform, 60 ft. long and 24 ft. wide, was suspended by two hangers on either side, the hangers being spaced 25 ft. apart, the distance between the bridge cross girders.

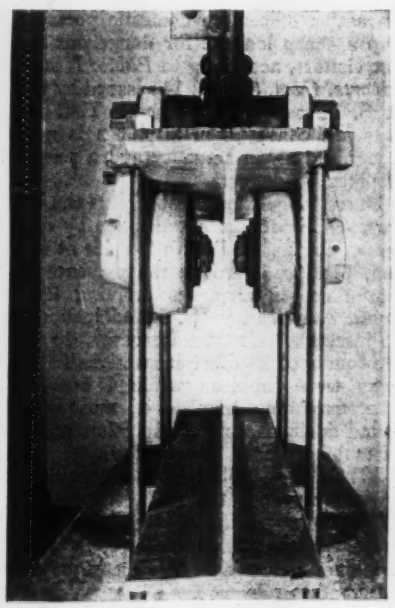
Design considerations

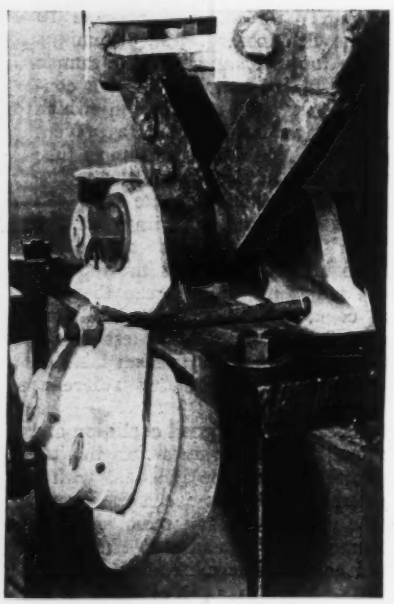
According to Mr. Paine's report, the scaffold weighed 20,200 lb., while live load of workmen, tools, etc., amounted to 3,600 lb. Assuming that two-thirds of the live load might be concentrated on one side of the scaffold, the two hangers on that side would have to carry a load of 12,500 lb. Under the condition of maximum loading, when the center of the platform was only 5 ft. from one of the supports, one of these two hangers would carry 0.8 of 12,500 lb. or 10,000 lb. Assuming further a 50 per cent impact factor, the design load for a hanger is found to be 15,000 lb.

This load is applied directly to the rollers of the trolley and, assuming that it is divided equally between the two side plates, Mr. Paine computes the bending moment on the critical section as 15,900 in. lb., and the extreme fiber stress in bending as 17,800 lb. per sq.in. Combining this with a direct tensile unit stress of 1,200 lb. per sq.in. gives a total combined unit stress of 19,000 lb. per sq.in.

"It is recognized," says the report, "that several uncertainties of load are present. The hanger is extremely short and owing to this a slight misplacement, when attaching it to a floorbeam preparatory to receiving the trolley beam, would cause it to receive a side thrust in the later movement of the platform. There is always the possibility that one side plate of the trolley might receive more than one-half of the total trolley load. Also there is the probability that frequently the loads on the trolley beam might be applied to the extreme ends of the rollers with a resulting increase in bending moment on the side plates."

TESTING A HANGER such as was used to support the scaffold which fell from the Golden Gate Bridge. At the left the load is being applied to the rollers of the cast aluminum trolley hanger through a beam whose flanges correspond to the inward slope of the rolls. At right, failure of the casting at a load of 14,270 lb.





Hanger tests

Two complete hangers were loaded to destruction in a testing machine, the procedure in both tests being identical except that in the first test the load was applied at a uniform rate of 4,000 lb. per minute while in the second test the rate of loading was 1,000 lb. per minute. The first test was made with the load transmitted through a short length of a 16-in. 36-lb. Carnegie beam with straight flanges whereas the rollers had been made conical in shape (the end adjoining the side plates being $\frac{3}{16}$ in. larger in diameter than the other end) to fit the sloping flanges of a 16-in. 36-lb. Bethlehem section. The hanger loaded through the Carnegie section failed under a load of 20,900 lb. Failure was by fracture of the aluminum casting at the critical or weakest section and at the same point that the hanger which remained attached to the bridge after the scaffold fell had failed. In this test it was noted that the load from the beam flange was delivered to the rollers at a point close to the inside and that the outer ends of the rollers were not bearing against the beam flange. The bending moment to which the side plates were subjected was therefore a minimum which explained the apparent inconsistency with the computations.

In the second test a Bethlehem section, corresponding to the one used in the scaffold, was employed for loading the trolley; it failed under a load of 14,270 lb., the aluminum casting fracturing suddenly at the same critical section.

The aluminum castings had the following properties:

	Test 1	Test 2
Yield point, lb. per sq. in.	13,250	13,400
Ultimate strength, lb. per sq. in.	16,500	16,350
Elongation in 2 in., per cent	0.75	1.0
Reduction in area, per cent	0.50	0.1

Industries Cooperate with City To Build a Separate Water Supply

Construction half completed on the new Birmingham water system which is to be used for industrial purposes only

AN INDEPENDENT water system for industrial users in Birmingham, Ala., is being built by that city under an arrangement whereby a number of industries signed contracts for the purchase of sufficient water to guarantee payment of the bonds before construction work was started. The project, costing nearly $6,000,000, includes an impounding reservoir, a diversion reservoir, and a 39-mile pipeline. Construction operations were begun in January, 1936 and are now more than half completed.

As the largest industrial city in the county not having a lake, river, canal or other substantial body of water nearby, Birmingham has long felt the need of an industrial water supply. The city is located in a long valley, between two mountain ranges, with one creek draining the major part of the valley. This stream is polluted by sewage and consequently, as a source of supply, it is wholly unsuitable. Although Birmingham has an ample water supply system for domestic purposes, this falls far short of meeting industrial demands.

Surveys made in 1928

Agitation for an industrial water system was begun back in 1928 when surveys were made. The present project was made possible when a $3,430,000 loan by PWA and a $2,378,000 grant by the WPA were authorized. The loan is backed by the sale of city bonds, supported by revenue derived from operation of the system. A sufficient number of industries signed contracts for water to guarantee payment of the bonds.

Water will be impounded on the Blackburn fork of the Warrior River where an earth and rock filled dam is being constructed. This dam will be 185 ft. high and 1,500 ft. long, creating a reservoir of 22 billion gal. capacity, covering approximately 6,080 acres.

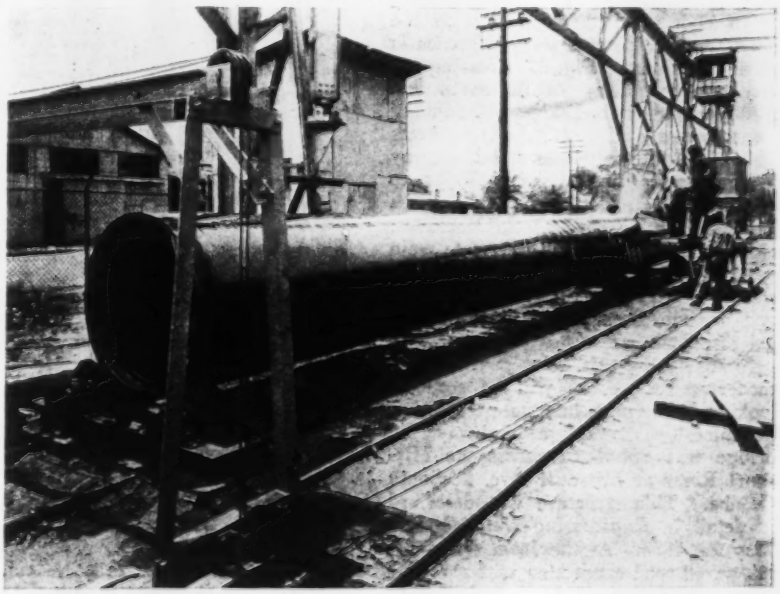
The water will be brought through a 60-in. welded steel pipeline to the distribution system at the city limits where cast iron pipe is used, ranging in size from 16 to 24 in. About midway of the transition line is a distribution reservoir, with a capacity of 120 m.g. This storage is designed to provide a uniform gravity pressure, afford a factor of safety in case of breakdown and permit intermittent pumping from the impounding reservoir.

Preliminary engineering work for the water supply system was done principally by A. C. Decker, consulting engineer. Since the project has been approved, an engineering commission has been placed in charge, including A. B. Polk, executive engineer; Harry Hendon, resident engineer; A. C. Decker, and O. G. Thurlow, consulting engineers; and J. D. Webb, Birmingham city engineer. Assistance was also given by WPA and PWA engineers.

FIG. 1—DIVERSION TUNNEL from the Blackburn fork of the Warrior River.

FIG. 2—DISTRIBUTION LINES of cast iron, from 16 to 24 in. in size are being laid to provide industries with water from source 39 miles from the city.

FIG. 3—STEEL PIPE used on the transmission line is coated inside and out with a bitumastic material before being laid.



Superstreet Design in Omaha

Arterial streets being modernized and repaved to provide for interstate traffic access and dispersion—Heavy pavement varied in character to suit service requirements

By Hardy Trustin
City Commissioner and Engineer, Omaha, Neb.

ARTERIAL street construction by which great state and interstate traffic routes enter and traverse cities is a notable recent activity. This work is not confined to cities of over-a-million population but is going on where a quarter and a half million or something more are big population figures. Omaha, Neb., is a noteworthy example in this smaller-population class because its super-street work is improvement of existing streets and not creation of new thoroughfares extrapolated into an existing street system. As an operation of its kind the new Omaha street work described here has challenging interest. —EDITOR.

IN ITS GENERAL RUN of street work Omaha is not changing or departing from the paving practices that it has used and that are in line with modern design and construction. But Omaha has recently been doing some unusual work on a few streets and is planning more work of the same kind. It is believed that practice on these projects (there are three of them) offers something of interest to street engineers. All are similar in being a modernization of old streets for arterial road service of the present intensive character and all are developments for across-city passage and intercity diffusion of state and interstate traffic.

To coordinate the reader with the general traffic service plan, reference is made to the map, Fig. 3. Crossing the city about midway of its north and south dimension is Dodge St., running directly east and west. As it connects at its east end with the street railway bridge across the Missouri River to Iowa and at the western city limits with U.S. 30, a main road across Nebraska, Dodge St. is a state and interstate main road. It is as such a road that the street has general traffic importance and its improvement has extra-municipal significance.

Similarly the two other streets being modernized have, as will be seen by looking at the map, interstate traffic importance. In 1935 a highway toll bridge was completed across the Missouri River at Missouri Ave. in South Omaha. This structure was described in detail in *Engineering News-Record*, May 23, 1935. At the Iowa end a 5½-mi. paved road connecting with the state system was built as a part of the bridge route, but in Omaha the bridge ended in plazas which distributed its traffic to existing streets. The new improvements are modernization of two of these streets into arterial routes, Missouri Ave. running west into the busy stockyards district and 13th St. extending north into the city's commercial and business center.

Repaving Dodge St.

The new Dodge St., 13th St. and Missouri Ave. will be arterial roads in a state and interstate system but they remain city streets, transformed streets it is true, but not extra streets. It is in this characteristic that the new Omaha arterial roads are perhaps a little distinctive. But it is the main purpose of this article to present the design details which too, it is believed, are somewhat distinctive, and the three operations are considered in the order just named.

FIG. 1—STREET-LIGHT and traffic-signal posts installed on Dodge St.

The largest of the operations was repaving and widening Dodge St., which has been completed. The work was done by the Nebraska State Highway Department with funds apportioned to the state through the Bureau of Public Roads. Within the city limits the improvement included repaving and widening as was just said; reduction of steep grades, and the construction of a grade separation (Fig. 4) at the intersection of Dodge St., and Saddle Creek Road. The work came into the category of state and federal-aid roadbuilding because Dodge St. is part of Federal Highway No. 30-S, which as stated extends entirely across Nebraska.

The street as taken over for improvement was paved as a four-lane highway with two parallel-parking lanes for most of its length. In the reconstruction the old pavement was entirely removed and replaced partly with brick and partly with asphaltic-concrete surfaces on cement-concrete bases and a small part with reinforced concrete pavement. The several sections are shown by Fig. 5.

Description of the new pavement calls for only a few notes; current methods familiar to all are to be understood except where difference is noted.

Pavement crown modified

It has been the practice in Omaha on most streets to make the centerline profiles of intersecting streets meet as smoothly as possible, especially where the traffic on the intersecting streets is of about the same character. Dodge St. being an arterial highway and carrying much more through traffic at higher speeds than do the crossing streets, it was thought desirable to modify the practice. As shown by Fig. 6a, the crown of Dodge St. is only 4 in. in a width between curbs of 56 ft. and it is made up of a 1-in. parabola in the center 20 ft. and tangent plane surfaces for the side ones. At intersecting streets this across-profile was changed as shown by Fig. 6b. A broad shallow valley gutter was used, the normal crown of Dodge St. being deformed only in the parking-lane zones. This leaves the four driving lanes unchanged in crown profile; it is

FIG. 2—EAST AND WEST TRAFFIC of an interstate character across the city of Omaha now travels a newly paved Dodge St.

believed that this is a desirable practice for all arterial streets.

Another new practice on this street was the use of a combined curb and gutter inlet to carry away storm water. This inlet shown by Fig. 9, with some slight modification, is now being used on all new construction on state and federal highways in Omaha. A less expensive construction than that shown by Fig. 9 is a precast concrete curb inlet and a separate concrete box with a cast-iron-grate cover; this inlet is now being used extensively. It is believed that both of these inlet designs, which make no notable depression in the street surface, add much to the safety of traffic.

Construction methods were modern but not unusual. The 20-in. concrete pavement is the heaviest ever used in Omaha, an 8-in. section having been usual. This old section was retained as base for the brick and asphalt surfaces. Both pavement and base were machine finished on the center 40 ft. but the outside lanes were finished by hand.

In the new brick surfacing, the latest bedding-course and joint-filler practice was followed. The mastic cushion was 96 per cent sand and 4 per cent cutback asphalt by weight. This mixture was produced in a standard asphalt plant, was hauled hot to the job and laid upon the concrete base in a manner similar to that used in laying a sheet-asphalt surface, except the rolling. A light compression only was effected in the mastic cushion by a hand roller, with a 24-in. tread, 36 in. in diameter, weighing 10 lb. per in. of tread width.

The brick surface was rolled with the conventional paving-brick roller. Previous to the application of the bituminous brick filler, the surface of the brick was sprayed with a solution of lime and water, the filler being applied immediately thereafter. As soon as the filler had cooled, the excess was removed with hand tools, leaving the spaces between the bricks well filled with practically no excess filler upon the surface.

It is felt that this mastic cushion for a brick-surfaced pavement is far super-

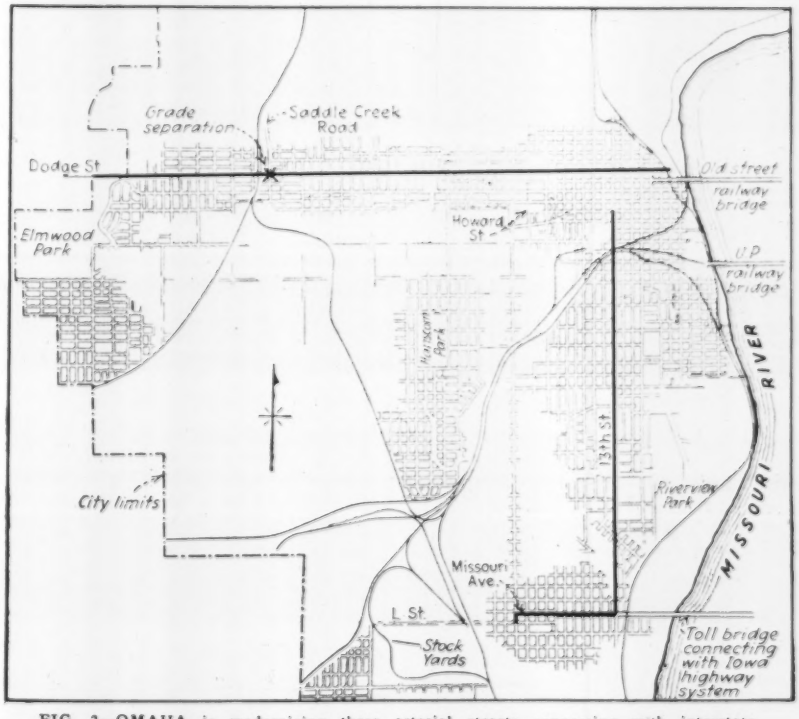


FIG. 3—OMAHA is modernizing three arterial streets connecting with interstate bridges to take away and diffuse the increasing bridge traffic.

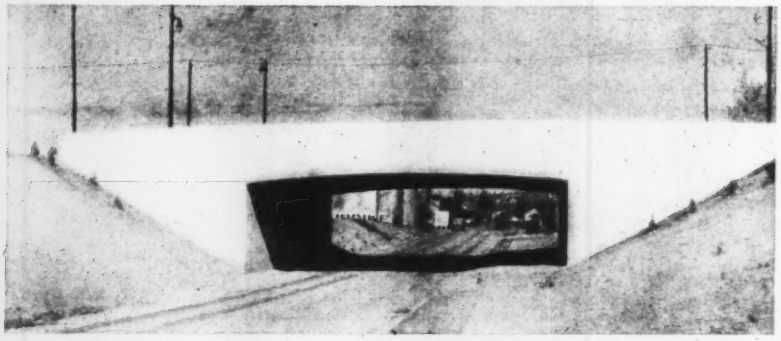


FIG. 4—IMPROVED DODGE ST. bridge over heavily traveled Saddle Creek Road where traffic is interchanged by a half clover-leaf intersection.

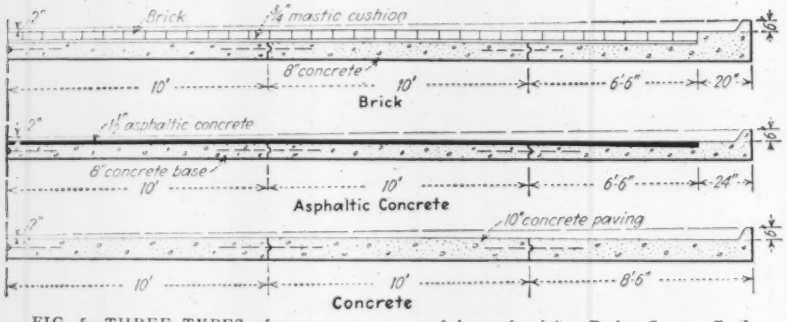


FIG. 5—THREE TYPES of pavement were used in modernizing Dodge St. to afford a comparison in service but the greater yardage was brick or asphaltic concrete.

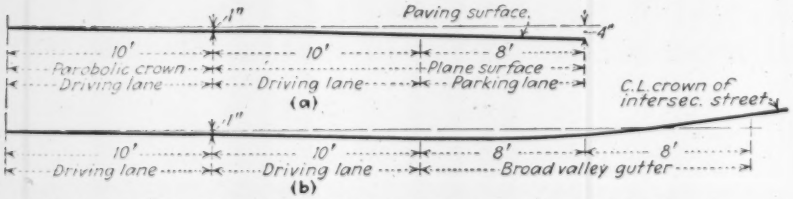


FIG. 6—NORMAL CROSS PROFILE (a) of Dodge St. was modified; (b) at intersecting streets to give them smooth access without altering the crown profile of the four travel lanes of Dodge St.

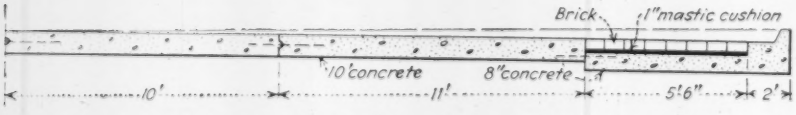


FIG. 7—A HEAVY-SERVICE CONCRETE PAVEMENT with brick parking-gutters takes the traffic between the new bridge and stock-yards.

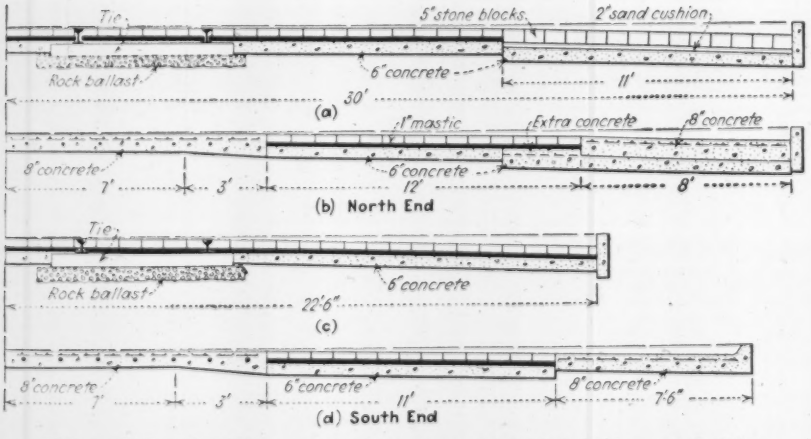


FIG. 8—OLD 13TH ST. is a reconstruction operation with a mind to standardizing varying sections, salvaging where practicable and providing relief-labor jobs.

ior to the old sand cushion; it resists displacement, and little, if any, is lost through concrete base cracks. It is believed, too, that the removal of excess filler is well worth while; (1) because the brick surface is left cleaner and the clean surface gives better traction in wet weather, and (2) about 25 per cent less filler is needed when the excess is removed and re-used.

New bridge outlets

A characteristic of the Dodge St. paving as shown by Fig. 5 is the designed parking lanes along each curb. These lanes are also integral parts of the improved street outlets for the new South Omaha bridge. Considering the Missouri Ave. outlet first, this highway, under contract to be built this spring, extends from 13th St. and Missouri Ave., the western terminus of the bridge, to 24th and L Streets, in the heart of South Omaha's business district. The new bridge is carrying a fairly heavy traffic today and it is expected that the completion of the new highway will increase the traffic over this route by a very considerable amount.

Fig. 7 shows a typical section of the proposed paving. The concrete slab is, as will be observed, a 10-in. reinforced slab with transverse expansion joints of the premoulded type at intervals averaging about 40 ft. The parking lanes are to be an 8-in. concrete base, with integral curb, surfaced with brick laid on a 1-in. mastic cushion. Transverse expansion joints are continued through the base at the same spacing as in the concrete slab, but instead of being of the premoulded type, are of sponge rubber. It is believed that this construction will minimize brick surface displacement cause by expansion and contraction in the concrete base.

South 13th Street reconstructed

The second bridge outlet is South 13th St. now being rebuilt by the Works Progress Administration. The repaving is about 3 mi. long on an arterial highway which extends from the new bridge at 13th St. and Missouri Ave. to the heart of Omaha's wholesale business district at 13th and Howard Streets. In design the improvement divides into two parts.

The northern end was paved 60 ft. wide, with a double street railway track in the center of the street. The paved surface was brick on a concrete base with gutters adjacent to the curb lines paved with stone block on a concrete base (Fig. 8a). The street railway tracks are being removed and the central 20 ft. of the street is being repaved with a typical 10-8-10-in. concrete highway slab with welded steel fabric reinforcement (Fig. 8b).

Construction joints are doweled with ¾x24-in round dowels. The usual deformed steel center line joint with tie-

bars is used but no transverse contraction or expansion joints. It is expected, of course, that an occasional blow-up due to expansion may occur and will have to be repaired. Transverse contraction breaks are expected to occur at intervals of about 30 ft. but it is believed these breaks will be small and easily repaired by the use of crack-filler. Up to date, the cracks seem to be quite regular and extend across the slab at right angles to the center line; this, of course, is due to the influence of the welded steel-fabric reinforcement. It is thought that this type of concrete slab will give a much better riding surface than that in which there are many joints of the conventional type and that the maintenance expense will prove to be lower.

Two types of new work

Fig. 8b indicates the typical section of the completed new paving. The old stone block gutters are removed and replaced with a reinforced concrete slab. All of the old brick surface is removed

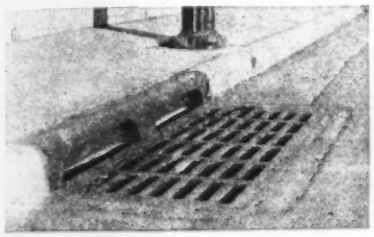


FIG. 9—CURB AND GUTTER inlets of cast steel and concrete were used throughout Dodge St. regardless of the type of pavement

and the concrete base brought up to the new grade by adding extra concrete on top of the old base. The bricks are then cleaned, turned, and relaid on a 1-in. mastic cushion and filled with bituminous filler. It will be noted that the finished surface consists of two central lanes of concrete each 10 ft. wide, two brick surfaced lanes each 12 ft. wide, and two concrete parking lanes each 8 ft. wide.

The southern part of this street is of somewhat different construction. The old paving (Fig. 8c) was 45 ft. wide, brick surfaced, and like the northern part, carried a double street railway track. The typical section of the new paving is indicated in Fig. 8d. Here, as in the northern part, the street railway trucks are removed and a 10-18-10-in. highway type reinforced-concrete slab is substituted. The brick surfaced area is also being rebuilt as in the northern part. The parallel parking lanes are 8 in. thick, of reinforced concrete with integral curbs. The complete paving surface (Fig. 8d) consists of two central lanes of concrete of 10 ft. each, two brick-surfaced driving lanes of 11 ft. each and two concrete parking lanes of 7 ft. each.

Serious Leak Checked In Cofferdam at Grand Coulee

Flow through deep sand stratum softens the base of part of the cofferdam and results in collapse of one cell—Inflow checked and reconstruction started

SERIOUS LEAKS into the cofferdam that keeps the Columbia River out of the area in which the east section of Grand Coulee dam is being built were discovered about the middle of March. Before the flow could be checked, one cell of the sheetpile section of the cofferdam collapsed, calling for major repairs and a change in the cofferdam plan.

The flow into the cofferdam now has been reduced to below a dangerous condition, the initial stage of reconstruction is well along and plans have been made for the steps to be taken before the next high water. Meanwhile, tests are in progress to determine how to shut off the flow completely.

Leaks increase in March

Flow into the cofferdam in the neighborhood of the junction between the main cofferdam and completed part of the base of the dam rose to 800 g.p.m. on March 17 and required the prompt installation of additional pumps to protect the area within the cofferdam from flooding. Settlement of material within affected cofferdam cells reduced the flow to 200 g.p.m. by 8 p.m., when the blasting of bedrock within the enclosure was coincident with a sudden and substantial increase in the leakage. A dike was constructed immediately to form a sump near the point of flow and to protect the east side and about 70 per cent of the central sections from inundation.

About midday on March 18, one of the cells on the inside face of the cofferdam burst, resulting in the deformation of adjacent cells, and in some displacement of a high steel tower supporting the suspension bridge that carries the aggregate conveyor and the cement pipe line across the river. The flow of water increased substantially, and immediately straw, sage-brush and other available binding materials were mixed with earth and dumped over the riprap fill, along the outside of the cofferdam, in an attempt to dam the leak from the outside.

An estimated maximum inflow of 65 sec.-ft. occurred on March 19. By April 1, the flow had been reduced to less than 30 sec.-ft. It is expected that

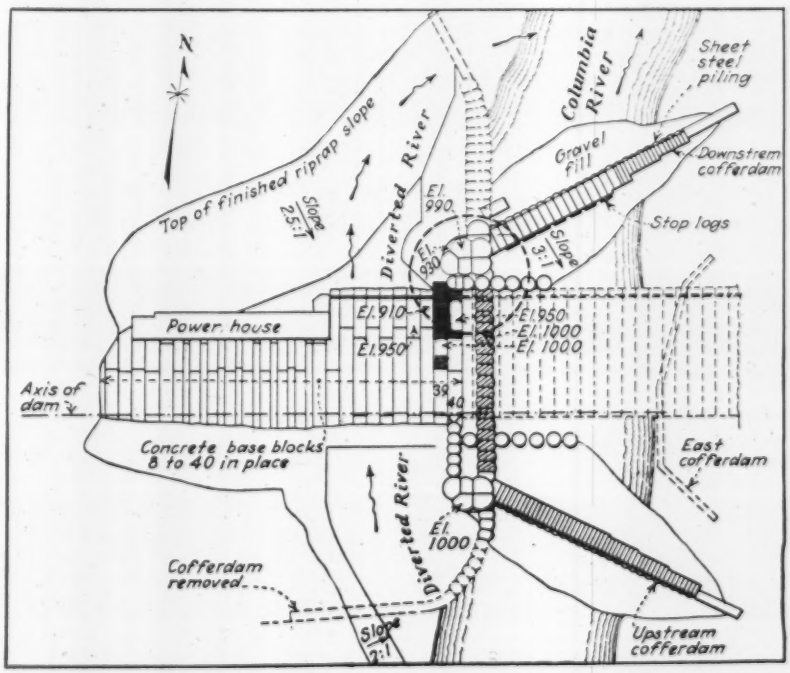


FIG. 1—COFFERDAMS at Grand Coulee Dam now enclose the east end of the damsite while the river is diverted through low blocks left in the completed base section on the west end. The circle indicates the area affected by underflow.

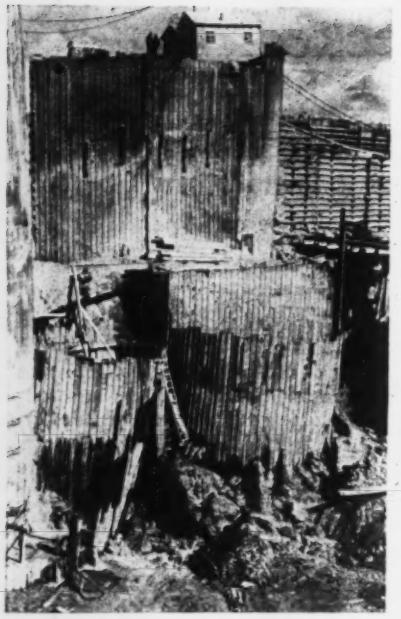


FIG. 2—LEAKAGE through the base of the cofferdam before cell G-3 failed. Cell G-3 is the large one in the background on which the office stands. The major inflow is in the left foreground.

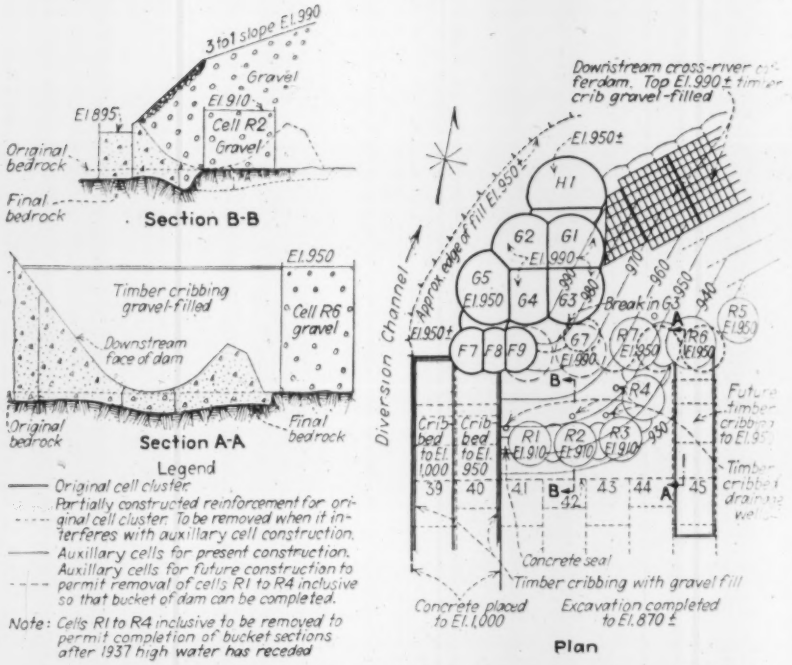


FIG. 3—CELL ARRANGEMENT at the point in the cofferdam where leakage developed in March. This is a detail of the area enclosed in a circle in Fig. 1.

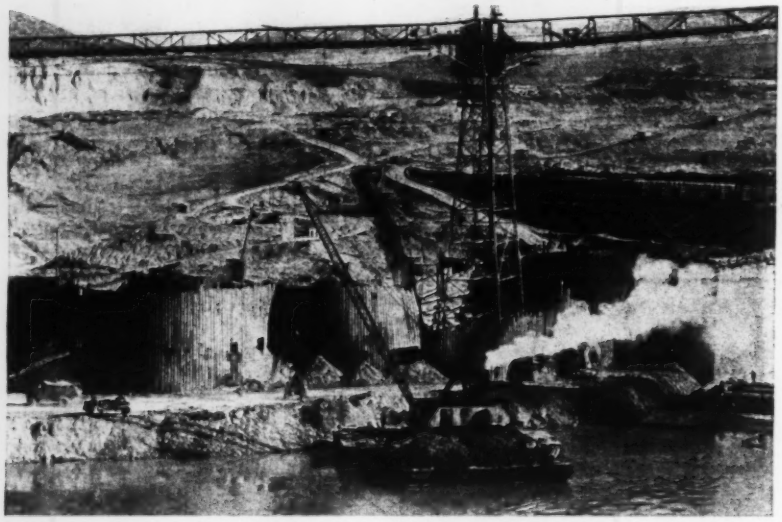


FIG. 4—OUTSIDE THE COFFERDAM brush and earth are being dumped on the slope to check the flow through the base.

by the latter part of April the work of reinforcing the cofferdam will be completed, and the flow of water stopped. Excavating and the placing of concrete on the east side has continued without interruption.

In Fig. 1 is shown the base section of the dam on the west side of the river, also the cofferdam cutting off the river bed and forcing the stream over low blocks of the west section, and, within a circle, the cofferdam cells affected. At low water stage of the river, the contractor removed the earth from behind the junction block at the intersection of the downstream cross-river cofferdam with the foundations of blocks 39 and 40, preparatory to reinforcing the inside toe of the cofferdam for the expected higher river heads at flood stage. The building of cells for the inner reinforcement had just been started when heavy leakage through the junction block cells, G3 and G4, started on March 17.

The original cell cluster and the inner reinforcement called for by the contractor's original plan are shown in Fig. 3, which shows, also, the proposed method of strengthening the structure. Fig. 2 is a view, taken just prior to the break, looking north towards cell G3, on which the small buildings are located. The inflowing water can be seen in the left foreground. The break occurred in cell G3, at the riveted seam directly below the two men in the picture.

Cell G3, just after the break, is shown in the upper view, Fig. 5. The frame buildings caught fire from a stove in one of them, and were burned. All men on and near the cell at the time escaped without injury. The inflow may be seen at the left of the cell base, and the impounded water in the foreground.

Reinforcing cells inside the cofferdam area, behind cell G3, are shown in process of construction in the lower view, Fig. 5. At the extreme left of this lower picture are: part of block 40, part of the crib system connecting blocks 39 and 40 with the G group of cells, and the base of the suspension bridge tower. The inflow, visible in the left foreground, will be diverted through spaces left by raised piles in the connecting arc between the first and second auxiliary cells to permit the placement of a concrete connection between the first reinforcing cell R1, and the crib to the left. When this connection is completed and cell R7 is finished, the raised piles will be driven into place.

A view of the outside of the disturbed section of the cofferdam is shown in Fig. 4. It shows the fill made over the original riprapped berm outside the cofferdam cells, a barge load of mats of small fir trees, a second barge from which sand bags were placed, openings in the cell walls cut to release filling material and relieve stresses, and the suspension bridge tower, which rests on concrete columns to bedrock in cells G5, G2 and G4.

The plans for strengthening the cofferdam and stopping the leak are in general as follows: An auxiliary ring

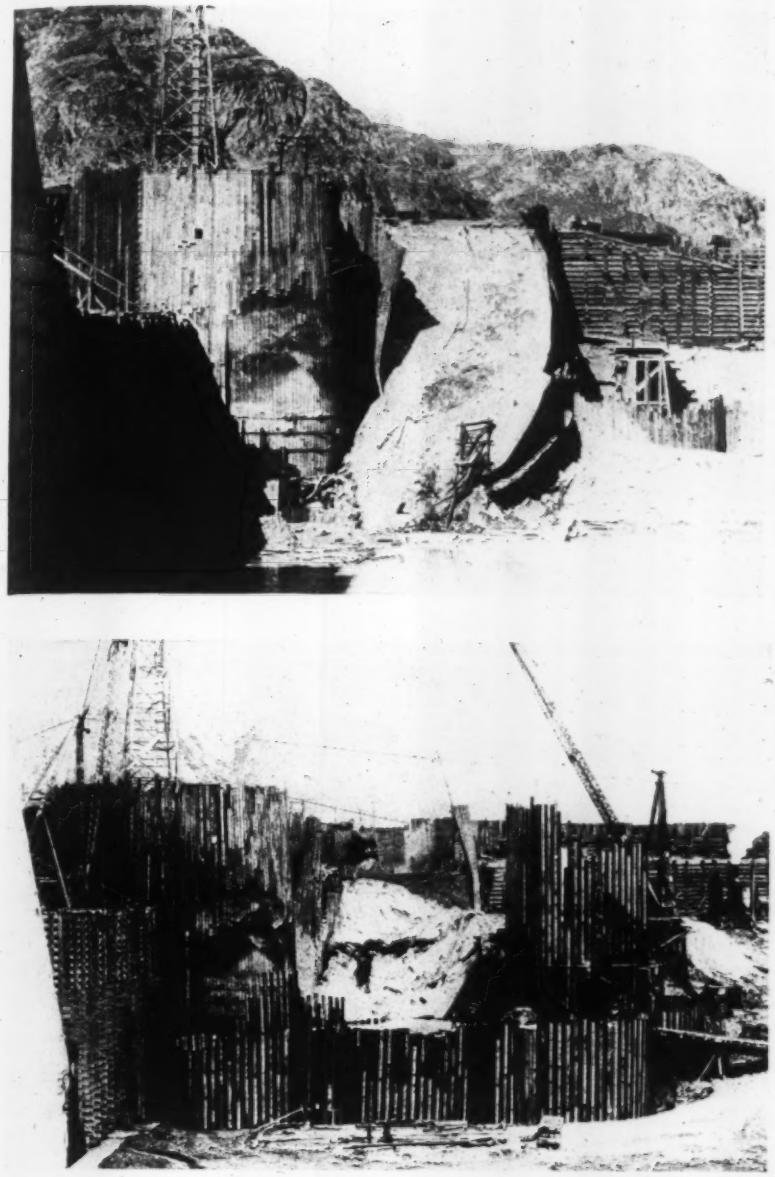


FIG. 5—CELL G-3 (upper picture) just after it collapsed into the enclosed area carrying with it part of the line of reinforcing cells then under construction. The new cells (R1 to R3, Fig. 2) are shown in the lower picture.

of gravel filled sheet pile cells, R1 to R7 inclusive, will be placed as shown in Fig. 3, running from the gravel filled timber crib on block 40 to the fill on the inside of the cross-river cofferdam. The intervening space will be filled with sand and gravel, with the fill sloping up on a 3 to 1 slope to the top of the original cluster (See Section B-B, Fig. 3). Cribbed timber wells will be placed in the fill just behind the auxiliary ring of cells to remove excessive hydrostatic pressure on the cells. It is thought that this, by increasing the friction and decreasing the gradient, will reduce the flow of water sufficiently to permit effective grouting of the leaks. An experimental model has been built, and experiments are being carried out to determine the best material or mixture to use for the grouting. Grouting mixtures of cement, various fine materials, such as bentonite, wood shavings, and sawdust are now being tested.

It is planned to concentrate work on the dam foundations in the area behind these auxiliary cells, placing concrete before the river reaches flood stage about the middle of June. Meanwhile, the space between the cells and the concrete will be filled with sand and gravel and the original cell cluster will be rebuilt to its original height and refilled. A timber crib will be placed east of the auxiliary cells on the concrete forming the bucket of block 45. It will hold out water which will be flowing over that portion of the spillway east of block 45, while auxiliary cells R1 and R4 are being removed and concrete for the buckets of blocks 41 to 44 is being placed, during the next low-water period.

Excavations in the vicinity of the affected cells exposed a substantially horizontal sand seam of varying thickness at about El. 896. Apparently this seam, which is below the bottom of the piling, carried some water, which finally resulted in piping and loss of ground. The general plan of attack is to place a heavy gravel fill behind the disturbed section of the cofferdam and then stop the flow by pumping into it material which will filter out into and seal the voids in the sand and gravel. With the flow reduced by such methods, effective grouting with cement can be done, and the flow can be stopped entirely without material interference with the construction program.

Work ahead of schedule

The base of the Grand Coulee dam is being constructed by Mason-Walsh-Atkinson-Kier under the supervision of the Bureau of Reclamation, Department of the Interior. The contractor's progress has been such as to point to completion of the present work about Jan. 1, 1938, or fifteen months in advance of the time specified in the contract.

Groundwater Levels in Utah

WATER LEVELS in most of the larger groundwater areas of Utah stood higher in the fall and winter of 1936 than in the corresponding period of 1935 according to a survey made by G. H. Taylor and H. E. Thomas of the U. S. Geological Survey in cooperation with the state engineer. During 1936 about 2,300 periodic measurements of water levels were made in 350 observation wells and about 1,400 measurements were made in 500 miscellaneous wells.

The average rise in groundwater levels was greatest in areas along the western base of the Wasatch Mountains. The rise in the Utah Lake valley averaged 5 ft. and in the Jordan River valley, 2 ft.

Only in the Cedar City valley, Iron County, did the water level in all observation wells decline. The average decline in 9 wells was 1.8 ft., and the greatest individual decline was 3.1 ft.

The rather general rise in level indicates that recharge through groundwater basins in Utah, most of which are artesian has been greater during the past year than the discharge. This has been caused in part by increased precipitation and in part by the adoption of conservation measures, consisting chiefly of the control of waste water from artesian wells.

CURRENT NOTES ON SEWAGE DISPOSAL

An analytical summary of recent developments conducted by

WILLEM RUDOLFS

Chief N. J. Sewage Experiment Station
New Brunswick, N. J.

● INDUSTRIAL WASTE AND FISH

In many instances it is rather difficult to determine by chemical methods the effect of trade wastes on fish life. Frequently, an industry located along a large stream can discharge its waste without affecting fish, while a similar industry located on a small stream may cause the death or migration of all fish. Schiemenz (*Fischerei Zeitung*, 277 and 393, 1936) called attention to the fact that inorganic wastes (acids, alkalies, salts) which contain no poisons are far less detrimental than organic wastes coming from sugar, starch, cellulose and similar type industries.

As a rule soluble mineral wastes disappear in the dilution water, while organic wastes do damage because of their avidity for oxygen. The writer stressed the fact that small quantities of organic waste are sometimes helpful rather than harmful because food is supplied to flora and fauna, and this in turn used as a food supply by the fish. Damage from mineral acids, (including sulfuric), is in general negligible and usually localized. On the other hand acid iron and mine wastes are very detrimental because iron combines with humic acids leaving the other acids free to destroy aquatic life.

● AEROBIC DIGESTION

When sewage sludge is added to the soil a rapid disintegration of the sludge takes place and the organic matter soon disappears. Some years ago experiments concerning the possibility of aerobic digestion of activated sludge, fresh solids and digested sludge were reported from the N. J. Sewage Experiment Station by Heukelekian (*Ind. Eng. Chem.* 1932, 1312; 1933, 1162) showing that considerable organic matter reduction took place when such sludges were aerated, even when anaerobically digested sludge was used. Experiments conducted at Manchester, England (Rivers Dept. *Annual Report* 1935–36), to determine the factors affecting the rate of aerobic digestion and the highest rate at which it is practicable to operate the process, showed that the rate of digestion was influenced by the proportion of the seeding sludge added. It was disadvantageous to use dense sludge on account of indifferent diffusion of the air bubbles. With one part of seeding sludge and two parts (by volume) of fresh activated sludge in a mixture containing about one per cent dry solids, an average reduction of 45 to 55 per cent organic matter of the fresh solids was obtained in 14 days. Considerable acidity was formed, due to nitrification. Adding sodium carbonate increased the amount of nitrates formed. The highest concentration of nitrates found was 840 p.p.m. Such material should be an excellent fertilizer, since it contains 8.4 per cent nitrates on a dry basis.

● HOME DISPOSAL SYSTEM

To prevent the extraction of fertilizing ingredients present in feces and to keep the waste liquid fresh by separating the feces from the water are the claims advocating the use of the "Dohns system" for isolated dwellings and estates (*Städtereinigung* 28, 394, 1936). Solid matter is screened out by means of a pre-settler consisting of a chamber with two vertical fine screens of different sizes placed behind each other, and a collection pit is provided to receive the solids. The water passes through the screens and is allowed to remain in an ordinary settling chamber for any time desired. The settling tank contains several baffles to keep back the scum, and they are arranged in such manner that they act to equalize the flow. This type of home disposal system is claimed to be superior because it prevents odors, allows the water to seep into the ground gradually and does not leach out valuable fertilizing materials which can and ought to be reclaimed.

● PHENOL REMOVAL

A number of different methods to remove phenol from gas house and mine wastes have been described and practiced and from time to time other schemes are suggested. Kappe (*Zentralblatt für Gewerbehygiene*, 23, 160–162, 1936) mentions an interesting method developed by a mine employee in Silesia, who adds the waste to the oil flotation process of coal. It is claimed that not only is the phenol entirely removed but, in addition, the quantity of oil required for flotation is reduced. It appears however, that in this particular case the de-phenolization process is affected somewhat by the frequently changing character and composition of the flotation oil. The composition of this oil, incidentally, is a secret of the industry. The fact that there are possibilities in this direction should stimulate the keen interest of investigators.

● MOGDEN PLANT OPERATION

What can be done with a modern flexible, well equipped and operated activated sludge-separate sludge digestion plant is shown by the recently published results (*The Surveyor*, Dec. 4, 1936) obtained at the Mogden (London) purification works during the first five months full operation. The dry weather flow was estimated to be 42 m.g.d. but the average flow during the period was about 48 m.g.d. The sewage was rather strong and contained about 307 p.p.m. suspended solids and 357 p.p.m. B.O.D. Double sedimentation accounted for a removal of suspended solids and B.O.D. amounting to 73 and 43 per cent respectively, while after aeration these removals were respectively 96 and 98 per cent. The effluent discharged was highly stabilized containing 3.3 p.p.m. nitrate and 18.3 p.p.m. nitrate nitrogen. These results were obtained with 6-hr. aeration of mixed liquor and 1.5 cu.ft. of air per gallon of sewage on the dry weather basis—actually, air consumption was less. The power required (38 hp. per m.g.) was obtained from sludge gas and there was enough gas.

● FILTER MEDIA FOR MILK WASTE

Treatment of creamery wastes on crushed stone and lath trickling filters has proven to be effective with dosage rates usually lower than those for domestic sewage. The effect of various types of media, including broken and solid cinders, quartzite, gravel, ceramic rings, broken clay tile and corncobs, has been reported upon by Levine, Nelson and Gorseline (*Iowa Eng. Exp. Sta. Bul.* 124). Experimental filters of 2 ft. square and 6 ft. deep received dosages at the rate of 550,000 gal. per acre, and were operated over periods of 16 to 20 hr. Purification was greatest with cinders, but they clogged rapidly. The corncob filters reduced the oxygen consumed values greatly, but produced no nitrification; during five months operation the filter shrinkage amounted to one-third the original size. With ceramic packing rings nitrification was quite satisfactory and did not clog as rapidly as cinders, gravel or broken tile. Short dosing cycles (2½ to 5 min.) effected higher purification, more constant runoffs and more nearly uniform composition of effluents than did longer dosing cycles. The more uniform the rate of runoff, the more nearly the peak efficiency of operation is reached for a given loading.

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

An Early Roadbuilder

THE COLOSSUS OF ROADS—A LIFE OF JOHN LOUDON McADAM—by Roy Devereux. 184 pp. Published by the Oxford University Press, London and New York. Price $3.

JAMES LOUDON MCADAM'S name stands side by side with that of Telford as the fathers of modern road construction. Of Telford, the profession now has an excellent record in The Story of Telford (*ENR* March 26, 1936, p. 465), and the present book gives an equally interesting though less extensive record of McAdam. American engineers will be interested to know that McAdam began his actice career in New York, coming here as a boy shortly before the Revolution to work with an uncle, a prominent merchant. When war broke out young McAdam took up arms on the British side. After the Revolution, along with many other Royalists, he left this country, returning to Scotland where he soon re-entered military service. It was in this service that he first took an interest in road building and with the Earl of Dundonald began his first experiments in road construction.

Railroad Contractor

END OF TRACK—Reminiscences of James H. Kyner as told to Hawthorne Daniel. 277 pp. Published by the Caxton Printers, Ltd., Caldwell, Idaho. Price $3.00.

END OF TRACK for James H. Kyner meant but one thing, a new opportunity for another contract involved in pushing railroad lines farther and farther into the undeveloped West. Jim Kyner lost a leg in the Civil War before he was out of his teens, and his story begins with an account of his boyhood and of his few weeks as a soldier, but the greater part of the book is devoted to an absorbing account of his many and varied experiences as a railroad builder. Beginning with a contract to construct a branch line of the Union Pacific R. R. in Nebraska, into which he entered without money to purchase equipment and without experience in railroad construction, Mr. Kyner gradually acquired both experience and money to finance and direct larger and larger operations until he was worth a half million dollars when the country went into the depression of 1893. As a result of that time of financial trouble, Mr. Kyner lost everything he had in an effort to carry forward a contract he had taken to build a railroad for a company that, as later developed, could not raise money to pay for his work. But he began again, with his two sons as his only helpers, starting out on extra-gang work and gradually assembling a considerable plant and organization with which to take larger contracts. Here is one of those all too rare accounts of the life of a pioneer constructor. And like any well written autobiography, it is more fascinating reading than fiction.

Gas Tax Record

GASOLINE TAX IN THE UNITED STATES—Publication 54. By Prof. Finlay G. Crawford. 50 pp. Published by the Public Administration Service, Chicago. Price 50c.

THIS FIFTH EDITION of an analysis of the gasoline tax situation brings the story up to date with tabular material revised completely and some new statistical data added. The conclusions drawn in the previous edition are not substantially changed. Former trends are now more definitely defined. The attack on evasions are more rigorous and in consequence collections are more efficiently done. Chapter headings are as follows: Growth of the gasoline tax, administration, exemptions and refunds, distribution, diversion, evasion, cities and the gasoline tax, and constitutionality.

Underwater Work

Reviewed by Wm. Wallace Wotherspoon

Consulting Engineer, Merritt, Chapman & Scott Corp., New York.

DEEP DIVING AND SUBMARINE OPERATIONS—Compiled and edited by Robert H. Davis. 510 pp. Published by The Saint Catherine Press, London. Price 18s.

THIS volume is the fourth edition of Robert H. Davis' "Diving Manual". Mr. Davis has been for many years the head of Siebe, Gorman & Co., manufacturers of diving helmets and diving dresses since 1819.

Probably no one possesses more accurate information on the art of deep diving than is Mr. Davis. He has written an instructive book, largely technical, dealing with research and practical experimental work carried out during the past three years by the deep-diving committee of the British Admiralty in collaboration with Mr. Davis' firm, with the physics and physiology of diving, with decompression, and with diving appliances. He has also written interesting chapters in the book for the layman, dealing with "diver's yarns" and "recovery of sunken treasure."

In recent years scientific research has revolutionized our knowledge of underwater conditions.

From ancient times men have endeavored to increase the narrow limits placed by nature upon their activities under water. It was not until the Middle Ages, loosely speaking, that we find inventors attempting to supply air to a man under water; while the history of modern diving is less than a century old—beginning, as it does, with the appearance in 1837 of the closed diving-dress and helmet invented by Augustus Siebe, the type of diving-dress that is in universal use today. This diving-dress followed the original form of dress, known as the open dress, introduced by Augustus Siebe in 1819.

Very early in the development of the submarine as a military weapon it was recognized that the problem of rescue of the crew and the possible salvage of the hull in the event of disaster, probably required deep diving. To this end the British Admiralty, and later the United States Navy, undertook an exhaustive series of experiments. As a result of these experiments the depth of diving has been increased from a little more than 100 ft. to three times that depth. The value of this work to those engaged in underwater work is very great and Mr. Davis has included it in his book.

New Wind Studies

Reviewed by W. Watters Pagon

Consulting Engineer, Baltimore, Md.

WIND-PRESSURE ON BUILDINGS—Experimental Researches—Second Series. Pamphlet No. 42. By J. O. V. Irminger, Chr. Nokkentved; translated by Alexander C. Jarvis and O. Brodsgaard. Pp. 85. Published by Danmarks Naturvidenskabelige Samfund, Copenhagen, Denmark. Price 10 Kr.

FOR over thirty years one of these authors has been experimenting to determine the pressures and suctions which develop on the walls and on the inside of buildings when the wind blows. From time to time they have published the results of their work, and this book gives the second series of experimental research. It has been translated from the Danish.

The results of their research that are of greatest value are those which come from their study of the effect of the ground upon wind flow. Comparative tests were made of models of various symmetrical shapes, which were contrasted with models of the same shape which were pierced through, on the axis of the wind flow, with a thin plate. Thus each half of the model simulated a building and the plate simu-

lated the ground. The significance of this series is that when a model is placed in a stream of air, it is entirely in order that an oscillating series of eddies will be shed, forming a vortex street. Now as I have attempted to estimate when determining the vibration of cylinders, this alternating flow can only be produced if there is an alternating circulation about the body. When a "ground" plate pierces the body, however, it is impossible for any circulation to take place about the body, and the flow on each half, therefore, is distinctly different. The authors find that the resistance coefficients of the half-bodies are from ½ to 2/3 of those for the symmetrical bodies, where of course it should be understood that the area is not involved, because the coefficient is the force divided by the area projected.

In the aerodynamic papers that I wrote recently (*ENR* Mar. 15, 1934 to Oct. 31, 1935) I made the statement that sharp edges bodies are independent of Reynolds number, with certain exceptions as found in Dryden's tests. These authors find a similar result.

There is a chapter on screens, one on open sheds, and a mathematical discussion of air flow, all of which throw new light on the problem of wind pressure on buildings. The book is of the greatest value to anyone who is concerned with wind pressure on buildings, bridges or other structures.

Miscellaneous Notes On Booklets and Reprints

EROSION CONTROL on mountain roads is the subject of pamphlet, circular No. 380, of the U. S. Department of Agriculture. Copies may be obtained from the Superintendent of Documents, Washington, D. C. Price, 10c.

THE RELATION of the University of Wisconsin to the conservation of Wisconsin waters has been made the subject of a study known as Science Inquiry No. 2. It is published as a bulletin of the University of Wisconsin, Madison, Wis., serial No. 2,193, November, 1936.

POWER PROJECTS of a non-federal character financed by the Public Works Administration are listed in a pamphlet entitled Non-federal PWA Power Projects, published by the Federal Emergency Administration of Public Works, Washington, D. C. Included are cost data, federal allotments, installed capacity of power plants, labor distribution, etc.

MOSQUITO CONTROL methods and a review of world-wide activities in control work, a symposium of 27 papers, will be published in the 1937 proceedings of the New Jersey Mosquito Extermination Association. Applications for copies should be addressed to Dr. T. J. Headlee, Rutgers University, New Brunswick, N. J., not later than May 10. The price is 75 cents.

STANDARDS FOR APPRAISAL PRACTICE have been issued by the Association of Appraisal Executives, National Press Building, Washington, D. C. in pamphlet form under the title "Basic Standards of Appraisal Practice and Procedure." Price not stated.

CENTRIFUGAL PUMP DELIVERY should be controlled by varying the pump speed in order to obtain maximum efficiency, according to A. Peterson in a paper for the American Water Works Association. The paper discusses the comparative economies of constant speed and variable speed drives for pumps and the several methods of obtaining variable speeds. Copies may be obtained from the De Laval Steam Turbine Company, Trenton, N. J.

PENSTOCKS are the subject of a report of the Hydraulic Power Committee, Edison Electric Institute, that presents data on progress since 1923 in the design and construction of penstocks, special connections and appurtenances. New designs for wyes, branches, surge tanks, connections, slip-joints and cradles are included. Price, $2.50 to non-members in U. S. A. from the Edison Electric Institute, 420 Lexington Ave., New York City.

DESIGN PROCEDURES for rigid frames are contained in two new university publications. Bulletin 89 from the University of Washington, Engineering Experiment Station, Seattle, is devoted to the solution of rigid frames of members of constant section by the theorem of joint translation. The price is 35 cents. The second bulletin from National Wuhan University Press, Wuchang, China, presents the application of the method of successive increment to problems of rigid frame structures. No price is given.

UNITS OF PROPERTY for use in connection with the uniform system of accounts prescribed by the Federal Power Commission have been published in multilithed form as Order No. 45 of the commission. Those interested in this order and in order No. 43, amendment to the uniform system of accounts, and order No. 44, the text of the commission's new rules and regulations, should communicate with John W. Jenkins, chief, Information Division, Federal Power Commission, Washington, D. C.

CONCRETE PILES, design, manufacture and driving. Published by the Portland Cement Association, 33 West Grand Ave., Chicago, Ill.

ELECTRICAL CONDUCTIVITY of fire streams, Research Series 53, Engineering Experiment Station, Purdue University, Lafayette, Ind. Price, 25 cents.

THERMAL EXPANSION OF TYPICAL AMERICAN ROCKS, Bulletin 128, Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa. Free.

GROUNDWATER LAWS IN ARIZONA and neighboring states; Technical Bulletin No. 65 from the University of Arizona, Tucson, Ariz.

New Books and Revised Editions

[*Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.*]

HIGHWAY SPIRALS, BANKING AND VERTICAL CURVES—By H. Criswell. 166 pp. Published by the Carriers Publishing Co., Ltd., London. Obtainable through the Engineers Bookshop, 168 E. 46th St., New York. Price $2.

THE SOUTH AMERICAN HANDBOOK—1937 EDITION—South and Central America, Mexico and Cuba. 674 pp. Published by Trade & Travel Publications, Ltd., London. Obtainable from H. W. Wilson Co., New York City. Price $1.

THE THEORY OF CONTINUOUS STRUCTURES AND ARCHES—By Charles M. Spofford. 267 pp. Published by McGraw-Hill Book Company, New York and London. Price $3.50.

PRINCIPLES OF ROAD ENGINEERING—By H. J. Collins and C. A. Hart. 628 pp. Published by Edward Arnold & Co., London, and Longmans Green & Co., New York. Price $18.50.

CURRENT DEVELOPMENTS IN HOUSING—Annals of the American Academy of Political and Social Science—Vol. 190. 285 pp. Published by the American Academy of Political and Social Science, Philadelphia, Pa. Price $2 (paper); $2.50 (cloth).

ELEMENTARY SURVEYING—By William Horace Rayner. 380 pp. Published by D. Van Nostrand Company, Inc., New York. Price $3.00.

MATHEMATICAL RECREATIONS AND ESSAYS—By W. W. Rouse Ball. 366 pp. Published by the Macmillan Company, New York. Price $3.50.

TENNESSEE VALLEY AUTHORITY—1933-1937—84 pp. Published by the Tennessee Valley Authority, Knoxville, Tenn.

BIG BUSINESS—ITS GROWTH AND PLACE—Edited by Alfred L. Bernheim. 102 pp. Published by Twentieth Century Fund, Inc., New York. Price $1.35.

THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS GUIDE: 1937 EDITION—Heating, Ventilating, Air Conditioning. 1156 pp. Published by the American Society of Heating and Ventilating Engineers, New York. Price $5.

FACING THE TAX PROBLEM—Prepared Under the Auspices of the Committee on Taxation of the Twentieth Century Fund, Inc. 606 pp. Published by Twentieth Century Fund, Inc., New York. Price $3.

PROCEEDINGS OF THE PUNJAB ENGINEERING CONGRESS—1936. Vol. XXIV. Edited by Members of the Council. 159 pp. Published by the Punjab Engineering Congress, Punjab, India . . . . *The papers of general interest in this volume relate to irrigation channel design, a silt selective distributary head regulator, an electrical method of determining pressure distribution under hydraulic works, and silt movements as affecting channel design.*

Letters to the Editor

All Charges Denied

Sir—A hearing on a suit filed in the circuit court of Cook County, Illinois, for the appointment of a receiver for the American Concrete Expansion Joint Co. of Chicago involves my name.

In this hearing the statement was made that 5 per cent of the corporation's stock was given to me under an agreement signed on Sept. 28, 1932, while I was chief highway engineer of Illinois and that I still own the stock.

This statement is absolutely untrue. I have never signed such an agreement and know nothing about it. I have never owned any stock in American Concrete Expansion Joint Co. of Chicago, and have never received any certificates for stock in that corporation or any dividends on any such stock, and I resent this unwarranted attack upon my business and professional integrity. Moreover, I have never owned any stock in, nor have I at any time in my career had any financial interest in any company which furnished materials or devices for highway construction, and I have never had any agreement, formal or informal, with anyone, under which I was to receive any stock or other financial interest in any such company.

FRANK T. SHEETS
Consulting Engineer

Chicago, Ill.
April 15, 1937

Seeing German Sewage Plants

Sir—After visiting sewage works in England, France, Holland and Germany I want to suggest to American engineers who expect this summer to go to Europe that they allow plenty of time for the procedure of getting permission to visit German plants. No one outside of Germany can see them without written permission of the German Foreign Office. The procedure is to make a written request of the American Ambassador at Berlin giving passport number and a list of plants one wishes to visit. He in turn writes the German Foreign Office and in due course, about two weeks, the permission is granted.

FRANK BACHMMAN

April 7, 1937
The 'Hague, Holland

The River's Rights

Sir—Your editorial entitled "The River's Rights," March 11, p. 385, suggests another comment.

It was a principle of law in the Central States during a considerable experience with flood waters and land drainage that the cost of a water way project was assessed according to benefits to be received. Damages were likewise assessed against the properties benefited. The equitable character of the costs and assessments was reviewable in court, assessors were appointed to determine damages in case of appeal to the courts. Many large areas were improved or protected with a minimum of appeal to courts for adjudication.

How large should the area to be reclaimed, protected or improved be, before it becomes too large for such methods of treatment. Granted that some problems may be too complete for such a solution, the principle of taxation according to benefits is a sound one and has been applied quite generally in making improvements and in furnishing protection in the East. We seem to be departing from the economic and legal principles involved as a result of numerous forces urging a new philosophy that tends to tax those not concerned with the benefits; and the latter are not disturbed about the cost, because they do not pay the bill. We must accept the social burdens created by social crisis but the tendency is to continue the construction of works for private protection at public expense after the immediate cause has passed.

The old principles were the foundation on which public improvements were based throughout a large part of our history. They should be continued where they can be applied equitably and humanly.

R. L. SACKETT
Dean of Engineering
Pennsylvania State College

State College, Pa.
April 7, 1937

Vierendeel Bridge Costs

In a letter to the editor published in the March 4, 1937 issue, p. 345, Prof. A. Vierendeel of Brussels, Belgium, commented on the new steel Vierendeel truss bridge in Glendale, Calif. (ENR, Oct. 1, 1936, p. 471) built by the U. S. Army Engineers in connection with the Los Angeles County flood control work. Professor Vierendeel raised the question as to whether the Glendale bridge was expensive since it had a heavy appearance compared with modern Vierendeel bridges in Belgium.

Reference to the record shows that three bids were received for furnishing: (1) 308,650 lb. of fabricated steel and other metal work; and (2) two fabricated steel Vierendeel girders weighing 97,400 lb. each. The contract was awarded to the lowest of three bidders. The bids received were as follows:

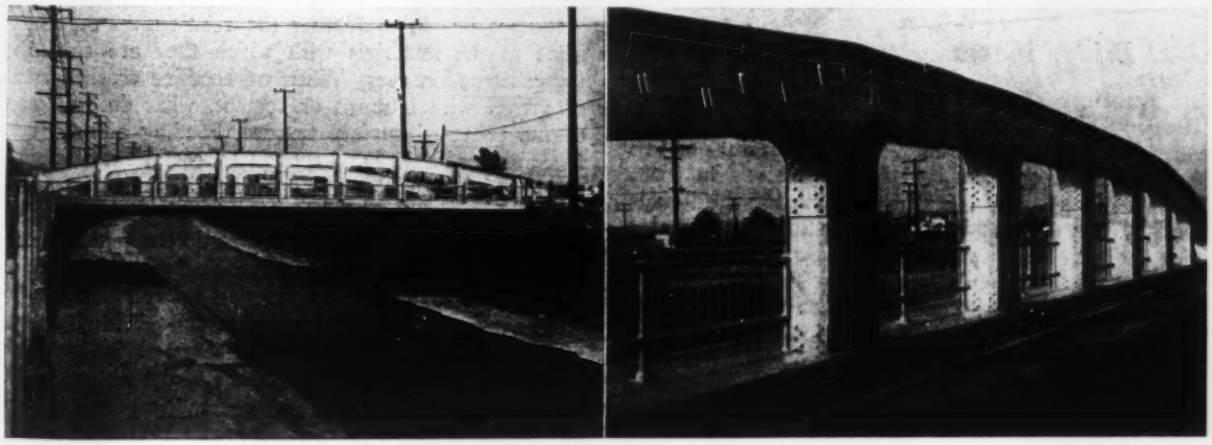
Consolidated Steel Corp.—(1) 7.5c. per lb.; (2) $9,947 each; total $43,042.75.

Bethlehem Steel Co.—(1) 7.75c. per lb.; (2) $12,020 each; total $47,960.38.

Minneapolis-Moline Power Implement Co.—(1) 8.25c. per lb.; (2) $11,500 each; total $48,463.65.

The bridge is located at the crossing of Kenilworth Ave. over Verdugo Wash in the city of Glendale, Calif.

STEEL VIERENDEEL GIRDER BRIDGE of 95 ft. span with 40 ft. roadway in Glendale, Calif. This is the first bridge of this type to be built in the United States.



ENGINEERING NEWS-RECORD

Volume 118, No. 16.

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Editorial offices at 330 West 42nd Street, New York

April 22, 1937

Part of a Whole

THAT bridges do not end at river banks but are mere local sections of complete transportation routes is brought to attention anew by the Omaha bridge. The stream of traffic that flows across a bridge is as little concerned with the location of the abutments as it is with the points where a fill or a cut meets the ground surface. Planning a bridge only from abutment to abutment is certain to make trouble, therefore, as in the case of the Missouri River bridge, where the city soon found that it must eliminate the bridge termini. It is doing so by an interesting piece of work that will enable the bridge to carry its traffic on wide superstreets far into and across the city instead of dumping it into a checkerboard of old streets. These superstreets have many points of interest, but their most instructive feature is the fact that they are afterthoughts.

Back to Normal

CINCINNATI WILL HAVE NO MORE OF THE PWA, its city council has decided. Characterized as "limping and halting" by City Manager Dykstra, the PWA program has been made additionally unattractive to cities by the new ruling that federal grants will cover only the amount of relief labor used. And so one city at least has mustered courage to tell its citizens that they must henceforth pay for their own public works, and it has done it by stating that such a policy will be cheaper. It might have cited the federal government itself as authority for the claim, because the Resettlement Administration has just asked for and obtained an exemption from the PWA relief-labor ruling on the ground that it can build twice as many houses with the same money if normal contracting methods can be used. In view of Cincinnati's decision to finance and build its public improvements by normal methods, other cities, whose mayors still junket to Washington with tin cup in hand, should begin to get suspicious. Cities that are paying through the nose for relief-labor public works should take note of Cincinnati's decision to return to normal methods.

Light Bridge Floors

ONE ELEMENT of the Outer Drive bascule bridge at Chicago whose significance may be missed by the casual reader is the light-weight deck. In the past year or two unusually large movable bridges have served to focus attention on the desirability of reducing the dead load; especially that of the floor. The situation has been met on several of the new bridges by new types of floor. The Outer Drive bascule is decked with concrete-filled steel grid units 3½ in. thick welded to the floorbeams. The Harlem River lift span of the Triborough Bridge at New York has a flat steel deck-plate covered with 1-in. mineral-surface asphalt plank. Still a third form, steel open-mesh decking, is used on the Marine Parkway bridge at New York, now under construction. Instead of 90 lb. per sq. ft., which once was common, these new floors weigh from 25 to 50 lb. per sq. ft. As weight savers they are obviously successful, thus reducing first costs. Their behavior in service remains to be watched and recorded for final appraisal of value.

Weak Details

WEAK DETAILS ARE KNOWN to be responsible for more structural failures than any other cause; yet, because this fact is easy to forget, the principal lesson of most structural accidents lies in reemphasizing the importance of attention to detail. Just now it is the fall of the Golden Gate floor scaffold that brings this fundamental teaching to the front. One of the four hangers that supported the scaffold was found broken, though still in place on the bridge, after the accident, which suggested that the hangers were too weak; this suggestion is now established as fact by actual tests of two companion hangers. Both of these broke at a bend or offset of their cast aluminum side plates, under a load about equal to the normal service load of the hangers. Granting that two tests are not necessarily conclusive, they do prove that the hangers had no margin of safety. There is no mystery about the weakness of the hanger plates; their design, which had to be as light as possible so that the hangers could be moved by hand, included a bend or offset that concentrated the stress of the plates severely and formed a critical section—at which section, in fact, failure occurred in all three cases. The material was poorly adapted to such severe demand. Yet the weakness of the detail escaped discovery by the contractor, the state safety inspectors, and the engineering staff of the bridge. In just this way weak details often escape detection. Whether or not the Golden Gate accident is ultimately attributed to the hanger plates or to the hook fastenings, the obvious fact is that the plates were too weak to perform the service expected of them.

We Don't Know

MINERAL AGGREGATES are familiar materials. They have been used a very long time for making cement and bitumen and clay mixtures, and it would seem that with such a background of practice we ought to know a good deal about them. But the fact is that, while a few things have been learned about aggregates by trial and error, yet engineer and constructor are in very poor shape to judge their merits. The common tests are woefully indecisive—witness the tests for structural soundness and resistance to weathering! But our real ignorance lies in evaluating the relationship of aggregates to the materials with which they are combined for construction uses. When we combine crushed stone or gravel with bitumen or cement, what do we know of the effect of surface texture, bonding affinity, surface area, angularity and soundness, coefficient of expansion, particle gradation and character? Today no rational tests are available. Nor can workability be measured. Perhaps a statement that best sums up the general situation is this one by Prof. Charles H. Scholer of Kansas State College: "There is growing appreciation of the fact that not all gravel is alike, nor all sands alike, nor all crushed stones alike, in their reaction to the materials with which they are mixed. What is the difference? I do not know. This being the case, it would seem that we need more research to improve our aggregate practice.

Are We So Wise?

QUESTIONABLE public-improvement schemes are a notorious hazard to our administration of public affairs. Only rarely are such projects so handled as to justify public approval. In the best of cases sane and practical considerations are a minor element in their discussion; in the worst cases the controlling factors are political intrigue, self-seeking, and efforts to exploit the public treasury.

Whenever such a scheme is being considered, the simple question is whether it will pay. The Florida Canal is a present example, though others might be cited. Do its benefits weigh up its costs? Unless the answer is expressed by a dollars-and-cent comparison a factual answer is not obtained. Under such circumstances responsible officials are required to assume an unreasonable burden of responsibility in deciding. On thin evidence or none at all they must predict whether the scheme will pay. We ask them in effect to indulge in crystal-gazing.

Repetition has made this process a recognized practice in public life. It is plainly a bad practice. It encourages officials to render arbitrary judgments cloaked as rational conclusions; any reasoning that may underlie these judgments is invariably superficial. However, the fault is not that of the officials but of those who ask them to attempt the impossible. It is the unjustified demand made upon them that, bit by bit, leads government officials into believing that they are wise enough to decide for all future time concerning the value of a particular project.

Are we so wise? The answer is in doubt on the very face of the question, and experience offers many instances that lend strength to the doubt. Consider waterways for example: Untold millions have been invested in them on forecast of profitable operation, and yet we have today a waterway system that is all but idle. Corresponding results will be found in many other cases where the value of the improvement depends on its earning power, all showing that prediction is disappointingly uncertain. The facts are less clear where the effects of the improvement include collateral benefits and social intangibles, but even here the public verdict on the outcome is often sufficiently unfavorable to strengthen one's doubts as to the wisdom of prediction.

So long as schemes of doubtful worthwhileness came up but rarely, and so long as their kind and dimension remained within the range of common understanding, the risk of wrong decision was not serious. Popular discussion and legislative scrutiny remained as a check. But when as in these days the number and size of schemes outrun this check we have little safeguard left. Then a group of officials with uncontrolled power to dispose of millions or even billions of dollars is under strong temptation to run wild on the strength of mere notions as to what is beneficial to the country.

There is a way out of the difficulty. Whenever there is doubt whether a project will pay, conduct its operation in such a way that it will pay if it can. Lay operating charges precisely as they would be laid if the operation were a private business, and account for income and outgo as rigorously as a railroad is required to account to the Interstate Commerce Commission.

Taking the Florida Canal as an example: Let it be placed on a self-sustaining toll basis that will cover carrying charges and amortization, and let the revenue be applied strictly to extinguishment of the expenditures and investment. If the toll charges then cause shipping to avoid the canal, we need not delude ourselves with the fiction that the canal nevertheless is beneficial.

Were it once made a principle of public administration that such projects will be approved under no other condition, the test of fact would soon lessen the readiness of officials to venture on rash prophecy where large public expenditure is at risk. It is true that the test of a project would come only after the expenditure has been made, and it might be held that therefore no restraint would be laid on unwise decision. However, the official or agency whose recommendations proved unsound would before long be effectively curbed by public disapproval.

If it should prove necessary, however, to guard against waste without waiting for the test of subsequent experience, a further safeguard is available. Questionable projects can be so organized that private investment money will carry the risk. No doubt private money often is foolish, but on the whole, especially in large-scale undertakings, it is remarkably prudent. Financed by private money on the security of their revenue, blue-sky public improvements would soon disappear, and public officials would be relieved of the burden of making impossible decisions. Perhaps the number of large works undertaken would be lessened, but we would have fewer white elephants standing as monuments to the present system of compulsory official optimism.

Lower Insurance Costs

ANY PLAN that shows promise of reducing the burden of compensation insurance deserves the consideration of contractors and others engaged in construction. Such a plan has been announced by insurance companies as the Compensation Retrospective Rating Plan—a formidable title for a relatively simple premium plan based on *actual* instead of *expected* losses.

As explained elsewhere in this issue by an insurance executive, the plan provides for a minimum premium 22½ to 30 per cent of that based on present-day rates plus actual losses and claim adjustment expenses. The assured is protected by a maximum premium of 25 to 75 per cent above standard, regardless of the extent of losses above this amount. To the contractor who is safety-minded and already enjoys a credit rating the plan offers opportunity for increased saving, as the premium is computed from the customary rating of the assured. To the contractor less fortunate in his loss experience, the plan offers a chance for immediate reduction in his costs if he can make a favorable accident showing on the job in question. Still further advantage is given the contractor who works in more than one state. Under the ordinary plan only his experience in the state in which the job is located is considered in making up the premium rates, while under the new plan his entire experience is considered, regardless of location of previous work. Thus, a contractor who has had no experience or perhaps an unfortunate one in a particular state is not unduly penalized on his next job there provided his whole experience has been favorable.

Unfortunately the retrospective rating plan, wholly voluntary on the part of the assured, has been approved in only one-third of the states. Contractors in other states might well inform the state insurance commission of their desire to have the plan adopted. It offers an opportunity to reduce compensation costs that should not be overlooked.

CURRENT NEWS

Less Public Works For Next Year

President's budget calls for economy and for reductions in flood control and highway work

Indications that federal expenditures for public works, particularly in flood control and highways, will be greatly curtailed during the fiscal year beginning next July were contained in President Roosevelt's revised budget estimates submitted to Congress April 20.

Pointing out that federal revenues are falling short of earlier estimates, the President indicated the extreme importance of balancing the budget during the coming year and appealed to Congress for its assistance by the extension of taxes soon to expire, and by the holding of expenditures within the limits determined by the Bureau of the Budget. Federal department heads have already been instructed to eliminate or defer all expenditures not immediately necessary, and it is hoped by this means to reduce the actual costs of the agencies well within the amounts appropriated.

Hold construction to $500,000,000

The President pointed out that bills are now pending in Congress that would, if passed, commit the government to early expenditures of over $3,000,000,000 for public works, whereas an annual program of $500,000,000 should meet normal needs.

"While I recognize many opportunities to improve social and economic conditions through federal action, I am convinced that the success of our whole program and the permanent security of our people demand that we adjust all expenditures within the limits of my budget estimate.

"I recognize the need for flood prevention and control, but it should be realized that to finance such large immediate expenditures as are contemplated by the majority of the flood control bills now pending in the Congress would impose an unjustifiable burden upon the federal treasury.

"Bills involving additional authorizations of more than $500,000,000 for highways have been introduced despite the fact that expenditures for this purpose during the last four years have exceeded one billion dollars and that there are existing authorizations for expenditures during the next two years of nearly $450,000,000."

Recommending the appropriation of $1,500,000,000 for relief during the next fiscal year, the President stated that his revised calculations indicated that this will mean, in place of the balanced budget predicted last January, a deficit of $418,000,000. He is determined to eliminate this deficit by two means: withholding a substantial proportion of appropriated funds from expenditures; and increasing treasury receipts through the liquidation of assets of some emergency agencies with recoverable balances.

HIGHWAY TAKES A LOAD

HAULING a 153-ton load was necessary when this 16-in. coast defense gun was recently trucked four miles from a railroad siding in San Francisco to Fort Funston on the ocean beach. The rear end of the gun is carried on a 16-wheel chassis built for a LeTourneau buggy. All wheels have pneumatic tires. The two motor trucks behind the gun were used for braking; the load was taken down grades as steep as 6 per cent. Ray Converse executed the hauling contract.

The truck haul over the first 4 miles, mostly downgrade, was made in 3 hours. The final 0.4 mile of the trip was up a 10 per cent grade; here the motor trucks were inadequate, and winches were substituted. Two days were required to traverse the 0.4 mile.

Load distribution on the level was 53 tons on the head end and 90 tons on the trailer. On the steep upgrade, load distribution was controlled by closing up the spacing between supports. Pneumatic tires were used exclusively; each tire had a 15-in. width of roadway surface contact. The maximum load per tire was 6½ tons.

Prevailing Wage Required On Nevada Public Works

An act passed by the Nevada legislature and signed by the governor on March 24 provides for the payment of prevailing wages on all public works in the state. Its provisions will apply on all public works undertaken by the state of Nevada or any of its political subdivisions, and the labor commission of the state is now proceeding with establishment of prevailing wage scales as set forth in the act. The highway department is also assembling data to establish prevailing wage scales on all contracts it lets in the future. A number of features were suggested by the Northern California Chapter of the A.G.C.

Provisions of the act

The act, which is patterned somewhat after the California law and to some extent after the Bacon-Davis national public works prevailing wage act, provides that every contract to which the state of Nevada or any of its subdivisions is a party, requiring the employment of skilled mechanics in the construction, alteration, or repair of any public buildings or other improvements, shall contain the provision that the rate of wages shall not be less than the prevailing rate of wages of the political subdivision of the state in which the work covered in the contract is located. Work done by or for railroad companies is exempted.

Prevailing wages in each locality are to be determined after hearings by the state labor commissioners.

A penalty of $5 per man day of employment at less than standard wages is provided for as well as fines of $50 to $200 and imprisonment of from 30 to 90 days for violations of the act.

Bridge Program Set Up In Maryland

Governor Nice of Maryland has signed a bill providing for a "comprehensive plan" for bridge building in Maryland." The bill creates a commission to supervise a bridge and tunnel planning program for the state. It authorizes the state road commission to issue revenue bonds for projects to be repaid out of tolls. After the tolls on the bridges have been used to pay off the bonds, they become the property of the state and can be made free bridges. Only projects costing $750,000 or more would be included in the plan.

Governor Nice stated, "It is possible that few bridges will be built under this legislation for some years. However, the way is now open for the state to become the possessor of bridges which it otherwise could not hope to build for many years to come, without cost to the taxpayers of the state."

The members of the commission are Richard F. Cleveland, Abel Wolman, and Enos S. Stockbridge of Baltimore; John B. Gray, Jr., of Prince Frederick; S. Scott Beck of Chestertown; Representative David J. Lewis of Cumberland; and Albert Phillips of Cambridge.

Globe Photo

WRECKAGE of a steel bridge across the San Juan River in Colorado. A truck-trailer which was on the bridge at the time of the collapse may be seen at one end, and a tractor and carryall, which were also on the bridge, are visible at the other end.

Texas Bridge Falls Under Load As Equipment Crosses

A steel truss bridge across the San Juan River six miles from Pagosa Springs, Colo., collapsed suddenly as a contractor rebuilding the road on which the bridge was located moved a large truck-trailer and a tractor and carryall across it. One man was slightly hurt.

The steel span had served the main highway from the San Luis to San Juan valleys for more than a generation. Several months ago the Colorado State highway department decided to rebuild the highway of which the bridge was a part, and included designs and appropriation for a new bridge.

Cook & Ransom, contractors on the highway project, had completed one section of the highway and were moving heavy equipment across the San Juan River when the bridge collapsed without warning. The large truck and trailer had almost crossed the bridge, and the truck was on the solid approach when the crash came. The front wheels of the trailer remained on the bank, the rear ones dropped with the bridge. On the other end of the bridge, a tractor was pulling a 12 yd. carryall. They went down with the bridge, and one man was slightly hurt.

The bridge was inspected immediately before the equipment was moved onto it, and it is believed that vibration set up by the equipment may have caused the collapse.

The bridge withstood a flood in 1911 which swept out other bridges along the San Juan River.

International Mechanics Group Will Meet in Cambridge

The American Committee which is organizing the Fifth International Congress for Applied Mechanics has announced that the congress will meet in Cambridge, Mass. Sept. 12-16, 1938, at Harvard University and the Massachusetts Institute of Technology. As in the past, this congress is to be a meeting of persons working in the field of applied mechanics before whom reports of recent work may be presented for discussion.

The program will cover three main divisions of applied mechanics: (1) structures, elasticity, plasticity, fatigue, strength theory, and crystal structure; (2) hydro- and aero-dynamics, gas dynamics, hydraulics, meteorology, waterways, and heat transfer; (3) dynamics of solids, vibration and sound, friction and lubrication, and wear and failure.

Further information on the congress may be obtained by writing to the Fifth International Congress for Applied Mechanics, Massachusetts Institute of Technology.

The American committee was made responsible for organization of the conference by the International committee at its 1934 meeting in England.

Sardis Dam Bids Rejected Army to Use Day Labor

All six bids submitted on March 9 for construction of the 14,000,000-yd. Sardis hydraulic-fill dam in northern Mississippi have been rejected by the U.S. Engineer Department as being too high. The project will be carried out on a hired-labor basis by the Army Engineer Corp. The low bid of $3,976,927, submitted by the General Construction Co., Seattle, Wash., was about 30 per cent above the engineer's estimate of $2,879,857. The high bid amounted to $5,915,020, more than double the estimate.

Sardis Dam will be built on the Little Tallahatchie River, near the town of Sardis, as the first of four reservoir projects planned for flood control in the Yazoo valley. It will contain 12½ million cu.yd. of hydraulic fill placed by floating dredges, topped by 1½ million cu.yd. of rolled fill. The main embankment will be 96 ft. high and 8,700 ft. long, flanked by earth dikes totaling 4,300 ft. long. The project will be under the direction of the U.S. District Engineer, Vicksburg. Col. L. E. Oliver is district engineer at present, but he is scheduled for transfer this summer.

Power Contracts Up for Revision

Contractors for Boulder Dam power seek revision of their contracts with the federal government

Hearings on applications for revision of the Boulder Dam power contracts were begun by the Department of the Interior on April 16, some of the power contractors having asked for a revision of certain provisions of the present agreements.

Under existing contracts, the firm power from Boulder Dam is allocated as follows: 36 per cent to the Metropolitan Water District of Southern California; 19 per cent to the Bureau of Power & Light, City of Los Angeles, and to other municipalities in the vicinity of Los Angeles; 9 per cent to the Southern California Edison Co. and to other power companies; and 18 per cent each to the states of Arizona and Nevada. Under its contract, the Metropolitan Water District has first call on all the secondary power.

At the opening of the hearings, John C. Page, Commissioner of Reclamation, stated that although the Bureau of Reclamation does not at this time advocate revision of the contracts there are a number of unsatisfactory features which the bureau would like to have adjusted if a revision of the contracts should be decided upon. Mr. Page stated that the federal government, in agreeing to finance the project, obligated itself to spend not more than $165,000,000, which is to be repaid with 4 per cent interest in 50 years. During the amortization period any revenues exceeding the necessary periodical payments to the United States are to be divided as follows: 18¾ per cent each to the states of Arizona and Nevada as payments in lieu of taxes; the remaining 62½ per cent is to be used primarily to repay $25,000,000 charged to flood control, and after this is completed, to a special fund to be expended under the direction of Congress in the development of the Colorado River basin. The government supplies the power equipment,

(Continued on page 608)

No-Strike Agreement On N. Y. Housing

New York City Building Trades Council agrees not to strike low cost housing projects

Mayor LaGuardia of New York made public on April 17 a letter from the Building and Construction Trades Council of Greater New York, Long Island and Vicinity in which organized building labor of the city pledged itself not to call strikes on any low cost housing projects undertaken in the city.

The letter from the Council was sent to the mayor as the result of a conference which he called on March 29 with labor leaders. The letter authorized the mayor to state for the building unions in any statement, testimony, or negotiation wtih federal and state authorities in connection with low cost housing programs, that labor in the city of New York is willing to enter into agreements:

"1. To establish the rates of wages at the time the specifications are drawn and requests for bids advertised.

"2. To enter into agreements with contractors that there will be no interruption of work during the course of the construction of the building provided in the contract, with the understanding that proper and satisfactory machinery would be provided for the adjustment of any differences which might arise in such construction; and

"3. To complete the work of the building covered by contract without demand for compensation additional to that specified at the time the specifications are advertised.

"In the event that union labor will not be available in any one trade . . . arrangements will be made whereby the contractor might obtain such labor in other localities."

Mayor LaGuardia, in a message transmitting this letter to Senator Wagner, wrote "I believe that this is the first time that any group of labor organizations in any city has taken such a progressive step, and I am deeply grateful to the leaders of the various groups who conferred with me on this matter. It was arranged that wages would be determined at the time bids were called and no readjustments would be asked during construction.

Chamber of Commerce to Study Construction Industry

The preliminary program for the annual meeting of the U. S. Chamber of Commerce, to be held in Washington April 27-29, reveals that a round table luncheon conference on the subject of "The construction industry's recovery problem" will be held in connection with the meeting on the afternoon of April 28. Mr. A. P. Greensfelder of St. Louis will serve as chairman of the conference.

Three subjects will be discussed: Mr. John H. Zink, president of the Heat & Power Corporation, Baltimore, Md. will discuss the subject "How can practical impetus be given to vocational and apprenticeship training." Mr. William A. Klinger, president, Associated General Contractors of America, will consider how seriously the established contract system is threatened by government activity. "How can the market for new dwellings be broadened" is the subject of a discussion by John McC. Mowbray, president, Roland Park Company, Baltimore, Md.

After the talks there will be discussions from the floor.

Fleming Leaves RA

It has been indicated that Lt. Col. Philip Fleming, Deputy Resettlement Administrator, will leave the RA and return to the Corps of Army Engineers June 30. Army orders have been issued transferring Colonel Fleming to St. Paul, Minn.

Colonel Fleming left the Corps of Engineers several years ago to take the position of Assistant Public Works Administrator and was later put in charge of the tidal power project at Passamaquoddy, Maine. When that undertaking was suspended, he was assigned to the Resettlement Administration to direct that agency's construction activities.

Relief Labor Not Required On Resettlement Housing

Secretary of Agriculture Wallace, under whose jurisdiction the Resettlement Administration has recently been placed, has obtained from President Roosevelt an exemption from the relief labor policies of the WPA, so that men employed in construction of Resettlement Administration houses need not come from the relief rolls.

Secretary Wallace has stated that the special labor exemption would enable the RA to build houses at a greatly reduced cost. RA officials estimated that the use of unskilled labor had increased construction costs by as much as 25 per cent.

Secretary Wallace ordered that in future the cost of houses built on uncompleted resettlement projects may not exceed $1,200 in the South and $2,100 in the North. Under the reduced cost policy, RA expects to build 11,820 housing units during the next 14 months. About 2,700 such units have already been built.

Aerial Explorations Photo

HOSPITAL BUILDINGS ORIENTED TO MAXIMUM SUNLIGHT

NEW YORK motorists crossing the city's Queensboro Bridge over the East River are witnessing a complete transformation of Welfare Island. On the site of the bleak penitentiary, for years a landmark south of the bridge, a group of hospital buildings is rising. Beneath the bridge is a new power plant to serve them, and north of it (partly shown in the picture) is a nurses home. The steel frames of the six buildings for Welfare Hospital have just been completed by the Harris Structural Steel Co., and bids have been taken on enclosure and finishing work. Caldwell-Wingate Co. was low bidder at $3,711,000, but the contract awaits appropriation of funds. The cost of the buildings complete is about $7,000,000.

In the group of steel frames shown, the center 5-story unit is the administration building, the top two floors of which will be devoted to living quarters for 60 doctors. Each of the four 4-story V-shaped units provides wards for 400 chronic disease patients. Beyond the north building, on the axis of the group, is a smaller building to be used as a laboratory and a morgue.

The buildings are designed for maximum efficiency. Thus, they are made V-shaped so that the southern exposure, toward which all rooms face, will receive 240 deg. of sunlight as against 180 deg. if they had been made rectangular. Elevators and stairwells occupy the central towers and all service facilities such as kitchens, storerooms and laundries, are concentrated on the north sides. Each building measures 375 ft. between the ends of the V. The basic layout was developed by the staff of I. Rosenfield, engineer of the Department of Hospitals. Detail design was handled by the architectural firms of Butler & Kohn and York & Sawyer.

Gas in Basement Caused Blast

All investigators agree New London school explosion caused by gas leak in basement.

All reports of investigators of the explosion that wrecked the high school at New London, Texas, on March 18, resulting in the death of 455 persons, agree that the primary cause was the ignition, from a spark of an electric switch, of a mixture of gas and air in the unventilated basement. Experts of the U. S. Bureau of Mines further conclude that the gas leaked from gas lines and their fittings suspended in this basement beneath the first floor and that the gas did not seep through the soil from the surrounding gas and oil field. This latter point was determined by sinking 71 test holes to rock and subjecting the atmosphere in them to gas detector apparatus.

In the final report of the U. S. Bureau of Chemistry and Soils (preliminary report, *ENR*, April 8, 1937, p. 535), it is pointed out that the most explosive mixture possible with the gas used would have contained only 6.5 per cent gas and 93.5 per cent air. The Bureau of Mines points out that since the ignited gas was in an enclosed and substantially confined space, little or no opportunity existed for expansion at low pressure. Hence maximum opportunity was afforded to build up a high pressure as the explosion wave progressed, resulting in widespread destructive effects. It also concludes that the results would have been the same regardless of the composition of natural gas present.

In an extensive review of the various investigations made, the Texas Inspection Bureau, representing fire underwriters, states that "the much publicized theory of accumulated gas in the hollow tile walls was started through ignorance of the conditions, since there was no way in which free gas could enter the walls and, further, it was not a wall explosion. Also, while the whole question of the heater installation is subject to criticism, it had no bearing whatever on the explosion."

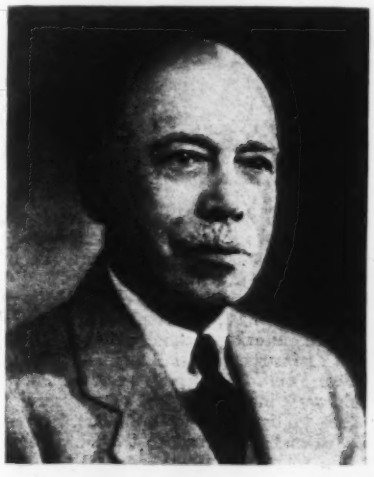
According to the Texas Inspection Bureau, Dallas, Texas, the school building was of good construction and planned for reasonable safety but the excessive area of concealed space under the building (254x58 ft.) filled with gas pipes and electrical circuits and without ventilation, was a serious fault. The four small vents in this area were not only too small and too few but were so far apart that they could not create circulation. "While the gas heater vents did not contribute to the disaster," says the report, "the evidence shows disregard for the hazard of non-ventilated gas fires in crowded

(*Continued on page* 608)

Ford Made Chief Engineer Of Rock Island Lines

Robert H. Ford, assistant chief engineer of the Chicago, Rock Island and Pacific Ry., Chicago, was appointed chief engineer on April 1 to succeed W. H. Petersen. Mr. Ford has been in the engineering department of the Rock Island since 1912, previous to which time he was chief engineer of the Hodge-Downing Const. Co. and assistant to the chief engineer of the Missouri Pacific Ry. He began work with the Central Vermont.

Mr. Ford has been active in railway engineering affairs for many years, is a



Robert H. Ford

past president of the American Railway Engineering Association and former chairman of the engineering division of the Association of American Railroads. At present he is a member of the A.A.R. advisory committee on grade crossing work.

W. H. Petersen, former chief engineer, becomes consulting engineer. He has been in railroad engineering work since his graduation from the University of Wisconsin in 1889, and has been with the Rock Island since 1906 when he was appointed bridge engineer.

Do You Take Pictures?

IF YOU MAKE A HOBBY of carrying a camera when you go over your job, some of your pictures may interest other readers of *Engineering News-Record*. Views of the less well known jobs will be welcomed as an aid in keeping our readers currently informed as to progress on the wide variety of activities in the engineering and construction field.

We will be glad to receive your pictures for examination; for such pictures as we are able to use we will pay a minimum of $1, and the name of the photographer will be printed under the picture.

Pictures to be acceptable must be of engineering interest; they may show current construction operations, job or structural details of general interest, or groups of people in the news, as when a tunnel is holed through.

Picture can be of any size but must be clear and sharp to make good cuts. They should be accompanied by information from which an adequate caption can be written.

Send pictures to the News Editor, *Engineering News-Record*, 330 West 42nd St., New York, N. Y.

To Curb Speculation In Columbia Basin

Proposed bill would limit individual land holdings to 40 acres and stabilize prices at arid value.

A bill has been introduced into Congress by Representative Leavy which is intended to prevent speculation in lands in the Columbia Basin which are irrigable by reason of the construction of the Grand Coulee dam project and to aid settlers in securing land at the appraised value as arid land.

The bill requires the Secretary of the Interior to determine the value of all irrigable land affected by the Grand Coulee dam project before the construction of the project, without reference to the proposed construction. It is further provided that repayment contracts for the cost of the construction of the project made between the government and irrigation or reclamation districts shall require that all irrigable land held in private ownership by any one owner in excess of 40 acres shall be designated as excess land and shall not be entitled to receive water from the project. Husband and wife may be considered as separate owners.

Limit on holdings

It is required that the contract shall provide that no owner of excess land shall receive water from the project for any part of the land he owns so long as he shall refuse to sell his excess land under terms and conditions satisfactory to the Secretary of the Interior and at the price fixed in the appraisal mentioned above. The Secretary of the Interior may require any land owner owning excess land to grant power of attorney to the government to sell such land before granting any water to the land owner.

The act provides that if the Secretary of the Interior shall find that in any part of the irrigable land of the project, farm units of less than 40 acres would be sufficient to support a family, he may reduce the allowable land ownership to as little as 10 acres.

Whenever any land in the project is sold at a price greater than the appraised value as arid land, it is required that 50 per cent of the excess of the price received above the appraised value shall be paid to the United States to apply against the cost of the project.

An expenditure of $350,000 of the funds appropriated for the Grand Coulee project is authorized to be used to make the appraisal of the arid value of the project land to be irrigated.

Highway Corporation Funds Freed by Court

The Alabama Highway Corporation was authorized by the circuit court of Montgomery, Ala., on April 9, to sell about $2,500,000 of road and bridge bonds to match federal funds.

The corporation was created by the legislature in 1935 and allotted one-twelfth of the state's gasoline tax for a period of five years, but the state comptroller had refused to turn over the funds, contending that state gasoline money had already been pledged. The court ruled otherwise.

Walsh-Healey Act Changes Urged

Exemption limit drops to $2,500 and service contracts included—new prevailing wage definition.

Senator Walsh and Representative Healey of Massachusetts have introduced companion bills in congress proposing amendments to last year's Walsh-Healey act which set minimum wages, maximum hours, and other restrictions upon contracts for supplies purchased by agencies of the Federal Government.

The scope of the act would be increased by a provision bringing under the terms of the act all contracts amounting to $2,500 or over, as compared with the former minimum of $10,000, and making the act apply to contracts for services as well as for "supplies, articles, materials, and equipment." As before, bidding is restricted to manufacturers and regular dealers, but a provision is proposed requiring dealers to secure the goods with which they supply the government from manufacturers conforming to the restrictions in the act; dealers would be required to submit certificates certifying to such compliance.

The group of contractors forbidden to bid on government contracts because of Walsh-Healey act violations would be expanded to include those "refusing to comply with directions or orders of the National Labor Relations Board."

A controversial amendment proposed is a new formula for determining the minimum wages to be paid labor engaged in the production of the contract goods. Senator Walsh points out that the present law is ambiguous in that it sets up three alternative, and not necessarily consistent, standards: the wages paid (1) on similar work, (2) in the particular or similar industries, or (3) in groups of industries currently operating in the locality. Although it was the intent of Congress to recognize geographical differentials, the word "locality" modifies only the third phrase.

As a substitute, Senator Walsh proposes the following: "The words 'the minimum fair wage' shall mean the minimum wage in an industry which has been determined by the secretary of labor after notice and hearings to be the prevailing rate of wages paid to the majority of persons employed in the industry at the minimum classification. Provided, however, that where no single rate is paid to a majority, the average rate shall be taken as the prevailing rate . . ."

Southern Congressmen claim that this amendment would eventually destroy geographical differentials. The secretary can prescribe as a minimum what is actually the prevailing wage in a low cost area only if more than half of the workers are in that area. Otherwise the averaging process, they state, will mean that manufacturers in a low cost area will find it necessary to increase their minimum wage in order to secure government business. Once the new level becomes established, it will again be averaged with high cost areas, to become a new and higher federal standard, and the process would continue until all differences between sections were eliminated.

Other modifications proposed by the new bills include: a provision that overtime wages need not be paid for more than eight hours of work in a single day if the employees total times does not exceed 40 hours in that week; confirmation of Secretary Perkins' ruling that the "open market" exemption applies only to purchases made without advertising for bids; addition of contracts with public utilities to the exempted list (already accomplished by administrative order); and a proviso that the president may suspend the application of the act to any contract in times of emergency.

Jay J. Morrow Dies at 67

Brigadier-General Jay J. Morrow, retired engineer officer and former governor of the Panama Canal, died April 16 in Englewood, N. J. at the age of 67.

General Morrow left the U. S. Military Academy in 1891, and, after attendance at the Engineering School of Application, served as instructor in military engineering at West Point. His service at West Point, which was interrupted by active service in the Philippines in 1898, lasted until 1901, when he returned to the Philippines for two years as military governor of the province of Zambonga. He was engineer-member of the board of commissioners for the District of Columbia from 1907 to 1919.

He first went to the Canal Zone in 1916, serving as engineer of maintenance and assistant to the governor. During the war he served in France as chief engineer of the First American Army and deputy chief engineer of the American Expeditionary Force, being promoted to the rank of Brigadier-General while in France.

After the signing of the armistice, General Morrow resumed his position in Panama as engineer of maintenance, and in 1921 he was named governor of the Canal to succeed Colonel Harding. He held that position until 1924.

General Morrow retired from active service in 1922 at his own request, retiring with the rank of brigadier-general. In 1925 he was appointed American member and chairman of the Tacna-Arica Boundary Commission.

Power Contract Revision

(Continued from page 605)

which is to be amortized in ten years, but the power plants are to be operated by two of the contractors, the City of Los Angeles and the Southern California Edison Co.

Proposed changes

The Metropolitan Water District of Southern California has asked to be relieved of the burden placed upon it of purchasing power which it cannot use due to the fact that the power project was completed nearly two years ahead of schedule while the Colorado River Aqueduct, on which the power is to be used for pumping, will not be completed until late in 1939 or early 1940. The district also asks for a modification of the rate at which it is proposed to take power under the contract and for a reduction in the interest rate from 4 per cent to 3 per cent to make it more in line with the present cost of federal money. The district suggests that the United States absorb the $25,000,000 charge to flood control and possibly the $5,000,000 charged to navigation, in view of the fact that it is absorbing similar costs on other large power projects such as Bonneville and the projects of the Tennessee Valley Authority.

Operation of the power plant by the federal government instead of by the contractors is proposed by the district, and that the generating equipment be amortized in 50 rather than in 10 years.

Operation of the power plant by the federal government, on the other hand, is opposed by the city of Los Angeles, but the city seeks revision as regards the obligation for repayment of money spent for the flood control and navigation features of the project. It also proposes some changes in the method of payment.

The Southern California Edison Co. does not seek modification of the contract but if modifications are to be made it will put forward some proposals that it believes to be advantageous to all concerned.

Opposition to modification that would result in a reduction in the Colorado River basin development fund was expressed by representatives of the upper-basin states.

Basement Gas Caused Blast

(Continued from page 607)

schoolrooms. In this respect, the school officials, architects and heater salesmen were equally at fault. The few attempts to ventilate into the dead space of a blank wall, where no flues existed, were obvious deceptions to cover up an omission. . . . Practically all faults of construction and installation in the building were due to lack of supervising power such as would apply in communities having city ordinances. It serves to focus attention to the need of state laws on standard construction as well as approved standards for the installation of heating systems and electrical equipment in public buildings."

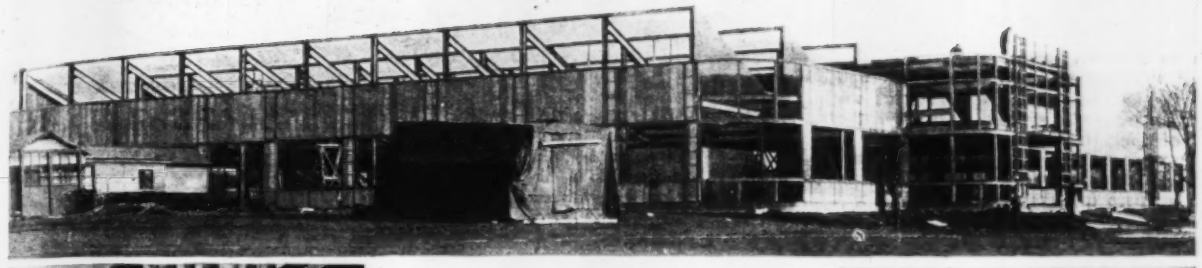
The Bureau of Mines report also urges a state supervising body to inspect public buildings lying outside the corporate limits of cities and towns, stating that the inspection should extend not only to the construction, but also to plans and designs of such buildings, and including the structural features as well as the details of heating and ventilation.

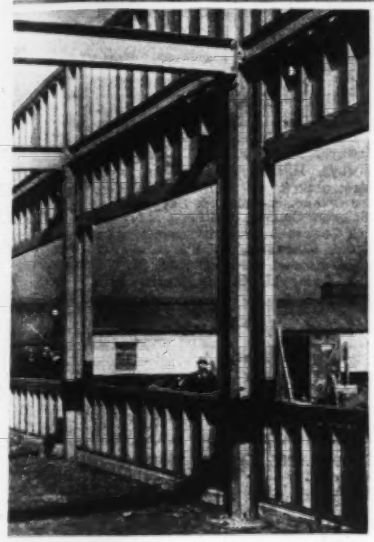
Another Railroad Is Proposed In Quebec Mining Area

A bill granting a charter to the Quebec Gold Field Transport Co. for the construction of a new 250-mi. railroad into the mining area of northern Quebec has been approved by the railway committee of the Quebec legislature and will now be submitted to the legislature for action. Construction of the line, which will proceed north from Mont Laurier, must start within one year, and must be completed within five years.

The bill has been opposed by the Canadian National Railways, whose own new line in this area is now well on the way to completion. Clearing of the right of way was finished during the winter, and grading and bridge work is now proceeding.

The province of Quebec is at present constructing a road in the same general direction as the proposed new railway line.





THE AMERICAN ROLLING MILL CO., in its new research building at Middletowns, Ohio, is blazing a new trail in the utilization of sheet steel for building purposes.

Applied to a welded steel frame is a wall of galvanized steel panels, set in 4 in. square pressed steel members, which is covered on the outside with porcelain enamel sheets trimmed in stainless steel and on the inside by furniture steel sheets attached to plywood backing; the 3½ in. wall space (*left*), is filled with rock wool. The wall openings will be enclosed with glass block surrounding standard steel window sash.

On the sawtooth roof (*right*) the covering consists of interlocking pressed steel channels perforated for acoustical purposes. The channels will be filled with ½ in. acoustical cork, a sheet of galvanized steel, and a layer of insulating cork 1 in. thick. The entire roof is then to be covered with a four ply waterproofing.

The building, which was designed and is being erected by the Austin Co., Cleveland, will contain 100 individual offices, laboratories, and conference rooms providing 41,900 sq.ft. of floor space.

SOCIETY CALENDAR

AMERICAN SOCIETY OF CIVIL ENGINEERS, spring meeting, San Antonio, Texas, April 21–24.

NATIONAL RIVERS AND HARBORS CONGRESS, annual convention, Washington, D. C., April 26–27.

NATIONAL LIME ASSOCIATION, annual convention, Chicago, Ill., May 11-12.

BUILDING OFFICIALS CONFERENCE OF AMERICA, national convention, Cleveland, Ohio, May 31–June 4.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Buffalo, N. Y., June 7-12.

ENGINEERING INSTITUTE OF CANADA, semi-centennial celebration, Montreal and Ottawa, Canada, week of June 15.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, annual meeting, Cambridge, Mass., June 28-July 2.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, New York City, June 28–July 2.

AMERICAN WATER WORKS ASSOCIATION, ILLINOIS SECTION, Springfield, Ill., April 29-30; PACIFIC NORTHWEST SECTION, Victoria, B. C., May 20-23.

AMERICAN SOCIETY OF CIVIL ENGINEERS, METROPOLITAN CONFERENCE OF STUDENT CHAPTERS, annual spring conference, New York City, April 24.

AMERICAN GEOPHYSICAL UNION, SECTION OF HYDROLOGY, annual convention, Washington, D.C., April 29–30.

MARYLAND-DELAWARE WATER & SEWAGE ASSOCIATION, annual conference, Wilmington, Del., May 6–7.

NORTH CAROLINA INDUSTRIAL SAFETY CONFERENCE, Winston-Salem, N. C., May 20–21.

NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS, annual meeting, New York City, May 22.

LICENSE EXAMINATIONS

NEW YORK: Examinations for registration of professional engineers and land surveyors will be given by the New York State Board of Examiners July 6, 7, and 8 at Albany, Buffalo, New York, and Syracuse. It is expected that assignments to these examinations will be limited to candidates who filed their applications before Jan. 1, 1937.

Vermont Ratifies Flood Pact

Before the Vermont Legislature adjourned its session, it ratified the 4-state flood control pact providing for the construction by the federal government of reservoirs in the Connecticut River valley at a total initial cost of $12,700,000 (*ENR*, April 8, 1937, page 533). Action has yet to be taken by Massachusetts, New Hampshire and Connecticut on this compact.

It is not yet known what effect the report of the National Resources Committee will have upon the above program. Extensive developments were suggested for five New England drainage basins, and the report recommended combining hydroelectric power production with flood prevention. The committe report included a supplement recommending the expenditure of $39,500,000 for improvements to the Boston water supply system, including three pressure tunnels to bypass existing reservoirs through which water is brought to Boston.

PWA Makes Four Grants On 45 Per Cent Basis

The Public Works Administration on April 12 announced four allotments under the old 45 per cent grant conditions to fulfil "moral obligations" to municipalities which had done preliminary work in the expectation of such allotments. The allotments were as follows:

A grant of $42,300 to the Marcus Union High School District No. 50, Washington, for a school to cost $94,000. This will replace an existing structure to be flooded out by the Grand Coulee reservoir.

A grant of $86,400 to school district No. 6, Weld County, Colorado, for a new building at Greeley and the alteration of several existing structures. Total cost of the work will be $192,000.

A grant of $45,000 to the city of Sherman, Texas, for the completion of an administration building to cost $100,000.

A loan of $59,000 and grant of $57,273 to Gallup, N.M., for a hospital to cost $127,272.

Obituary

FRED O. STEVENS, 57, for 20 years superintendent of the Weymouth, Mass. water department, died in Weymouth April 8.

GUSTAVE L. CLAUSEN, consulting engineer and sewer contractor, died April 5 in Chicago. Before he established his own

business in 1887 he was assistant engineer on the Pullman sewage treatment works and served as village engineer for Hyde Park. In the course of his consulting practice he designed sewer systems for Blue Island, Elmhurst, and other Chicago suburbs, and he was for several years superintendent of the sewer department of the city of Chicago.

E. E. SPETMAN who was for many years city engineer of Council Bluffs, Iowa, and since 1934 had been PWA inspector in Des Moines, died recently in Oklahoma on his way home from Mexico.

JOHN T. DAILY, 73, for many years secretary of the Arundel Corp. of Baltimore, died in that city on April 16. Mr. Daily became connected with the Baltimore Sanitary Construction Co. and the Baltimore Dredging & Construction Co. in 1893. He later served as an officer in the Maryland Dredging & Contracting Co. and the Furst-Clark Dredging Co., and when the Arundel Corp. was organized in 1901 by the merger of seven other companies, Mr. Daily became secretary, holding that office until his death.

JOSEPH S. STRINGHAM, city engineer of Detroit since 1931, died there April 2 at the age of 66. After graduation in 1895 from the Michigan College of Mines, Mr. Stringham worked as a surveyor and mining engineer in Colorado, California and British Columbia and was with the lake survey for the U. S. Corps of Engineers. He was later a member of the party which surveyed a possible canal route across the Isthmus of Darien and was construction engineer for the Solvay Process Co. for 11 years. He was appointed commissioner of public works of Detroit in 1930 and city engineer in 1931.

JOSEPH H. HELLEN, a retired contractor and president of the Builders Exchange Building Co. of Baltimore, died in Plainfield, N. J., on April 13 at the age of 82. Mr. Hellen, before his retirement about 25 years ago, had erected many important buildings in Baltimore.

WALTER J. SHERMAN, consulting civil engineer of Toledo, Ohio, died April 15 in that city at the age of 82. Mr. Sherman graduated in 1877 from Cornell University and later obtained the degree of C.E. from that institution. After a year as assistant engineer for the Lake Erie & Louisville R.R., Mr. Sherman spent three years as chief engineer of the Toledo, Delphos & Burlington R.R., and then for three years held a similar position with the Louisville, Evansville & St. Louis R.R. After four years in a similar post for the Gulf, Colorado & Santa Fe Ry., he began the practice of consulting engineering in 1888 at Dallas, Texas, doing work for various railroad, rapid transit, and manufacturing concerns. After some years in contracting work and a year as chief engineer of the Wheeling & Lake Erie R.R., Mr. Sherman returned to consulting work in Toledo, for some time as a member of the firm of the Riggs & Sherman Co. In the course of his consulting work, Mr. Sherman supervised construction of the Toledo waterworks. He was a life member of the American Society of Civil Engineers.

LARGER AWARDS FOR THE WEEK

150,000 HP turbo generator set for power plant, Ford Motor Company, River Rouge, Mich.	$5,000,000
Seminary, Vincentian Fathers, Northampton, Pa.	650,000
Residential development, J. H. McClatchey, Upper Darby and Haverford Townships, Pa.	1,000,000
Office and factory, A. B. Dick and Company, Chicago, Ill.	500,000
Housing development, Gross Morton Corporation, Bayside, N. Y.	1,000,000
High school, Wellesley, Mass.	612,000
Improving highways, own forces, Supervisors Ontario County, Canandaigua, N. Y.	1,000,000
Surfacing highways, own forces, Supervisors Monroe County, Rochester, N. Y.	656,000
Highways, Texas	1,882,000
Highways, Illinois	861,000
Superstructure of railway facilities, San Francisco-Oakland Bay Bridge, Alameda County, Calif.	537,000
Trunk sewers in various streets, own forces, Rochester, N. Y.	4,000,000
Sewage disposal plant, Greece, N. Y.	1,200,000
Sardis Dam, U. S. Engineers, own forces, Miss.	2,877,000

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Apr., 1937	230.25	110.64	Mar., 1937	147	64
Mar., 1937	225.25	108.18	Feb., 1937	181	79
Apr., 1936	202.20	97.20	Mar., 1936	160	70
1936 (Av.)	206.46	99.24	1936 (Av.)	185	81
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50

CONTRACTS
(Thousands of Dollars)

	Weekly Average Apr. 1936	Prev. 4 Weeks	Week Apr. 22 1937
Fed. Government	$1,386	$3,704	$3,500
State and Municipal	24,965	17,758	20,387
Total public	$26,351	$21,462	$23,887
Total private	12,741	23,885	20,421
Week's total	**$39,092**	**$45,347**	**$44,308**

Cumulative to date:
1936 (17 weeks) $758,377,000
1937 (16 weeks) $695,753,000

Note: ***Engineering News-Record*** **reports waterworks and earthwork, reclamation or** waterways projects of $15,000 and over in size; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000 and over. The figures above represent the **volume of contracts and large force account** projects throughout the U. S. that are of **these minimum sizes or over.**

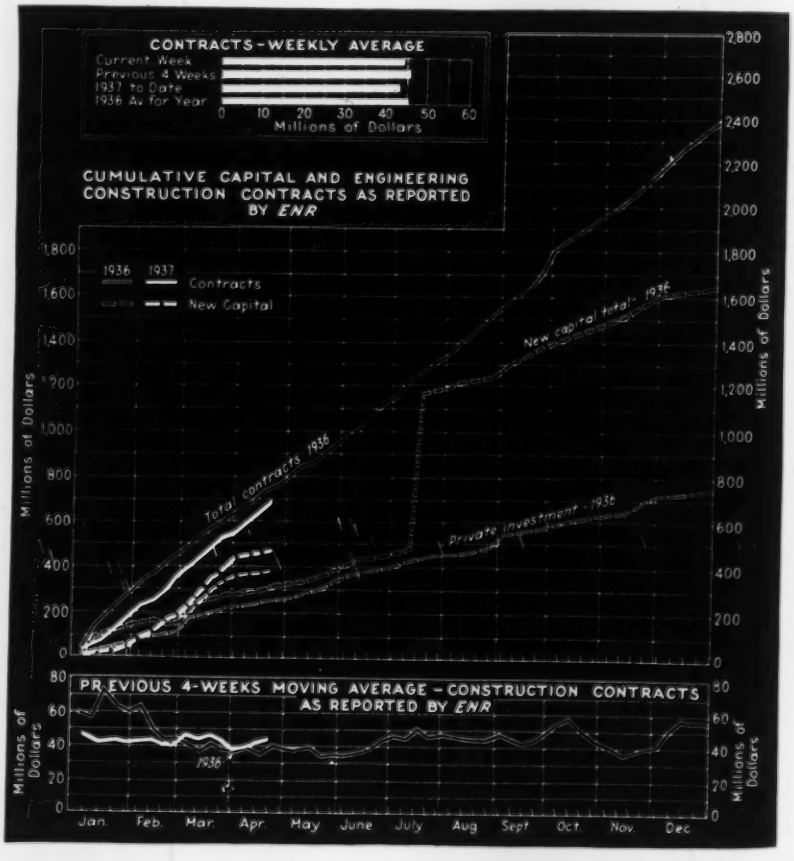
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

1937	Week Apr. 22	Cumulative
Private investment	**$10,944**	**$398,676†**
State and municipal bonds	5,992	174,652†
Corporate securities	4,952	224,024
Federal financing	**$290**	**$75,991†**
PWA non-federal Projects	290	46,859†
R.F.C. Loan	.....	29,132
Total non-federal	**$11,234**	**$474,667**
Federal projects	.....	.....
Total	**$11,234**	**$474,667**

Cumulative to date:
1936 (17 weeks) $343,107,000
1937 (16 weeks) $474,667,000

Note: These figures include private bonds and stocks sold for new construction purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, RFC direct purchase of bonds for "self liquidating projects, and 25 per cent of WPA construction appropriations.

† Includes transfer from federal to private investment financing through sale by RFC of PWA bonds.


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1937 to Date
1936 Av. for Year
0 10 20 30 40 50 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936 1937
Contracts
New Capital
New capital total - 1936
Total contracts 1936
Private investment - 1936
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936
Jan. Feb. Mar. Apr. May June July Aug Sept Oct. Nov. Dec

Current Construction Unit Prices

Montebello Water Tunnel, Baltimore

BALTIMORE is building an additional conduit from its Gunpowder Falls water supply to Montebello pumping plant. Contract was awarded in February, 1937, for a 12-ft. diameter pressure tunnel 6.6 mi. long and for 1,900 ft. of 10-ft. steel pipe in open cut. PWA labor regulations and minimum wages will apply. Leon Small, water engineer for the city, will be in charge of the project. Following are total bids and unit price tabulations of the three low bidders. (A) J. F. Shea Co., Inc., Los Angeles, Calif. (contract) $5,389,312; (B) W. E. Callahan Const. Co. & J. P. Shirley Co., Dallas, Tex., $5,405,610; The Arundel Corp. & S. S. Magoffin Co., Inc., Baltimore, $5,439,975.

MONTEBELLO WATER TUNNEL, BALTIMORE

Item	A	B	C
1. Tunnel excavation—34,590 lin.ft.	$93.05	$84.00	$93.00
2. Lining A & C sections—11,625 lin.ft.	87.66	80.00	75.00
3. Lining B section—22,965 lin.ft.	21.60	30.00	22.00
4. Excavate, install, backfill, steel plate pipe in section D—1,900 lin.ft.	70.83	115.00	90.00
5. Special const. at Loch Raven—total	54,084	75,000	60,000
6. Special const. at Montebello—total	456,960	550,000	600,000
7. Temporary bldgs., fences, etc.—total	10,000	37,600	15,000

Superstructure, Bay Ridge RR. Facilities

BIDS were opened Mar. 31, 1937, by the California State Department of Public Works for the construction of the superstructure of East Bay Yard railroad facilities and the Port of Oakland overhead, both part of the San Francisco-Oakland Bay Bridge development. Five proposals were received, all remarkably close, the range being from $536,960 to $587,586. The state reserves the right to eliminate the Port of Oakland overhead from the contract if it so desires. Contract for the substructure work of the two projects was recently awarded, and unit prices for this work were published in *ENR*, Apr. 18, 1937, p. 539.

Following are unit prices submitted by the three lowest bidders: (A) J. H. Pomeroy & Co., Inc., San Francisco, $536,960; (B) Barrett & Hilp, San Francisco, $537,689; (C) Bates & Rogers Const. Co., San Francisco, $548,099. Chas. H. Purcell is chief engineer of the department of public works.

SUPERSTRUCTURE, SAN FRANCISCO BAY BRIDGE RR. FACILITIES

Item	Unit Prices A	B	C
East Bay Yard and Sou. Pac. Ry. Crossing			
1. Struc. steel, S.P. overhead and 26th St. crossing—1,310,000 lb.	$0.077	$0.082	$0.077
2. Struc. steel in catenary bridges—1,400,000 lb.	.0925	.10	.093
3. Concrete—800 cu. yd.	19.00	22.00	26.25
4. Reinf. steel—160,000 lb.	.05	.05	.055
5. Cast steel shoes——30,000 lb.	.18	.20	.24
6. Pipe railing—12,000 lb.	.15	.25	.27
7. Timber—M f.b.m.	120.00	100.00	115.00
8. Painting, 26th St. crossing—440 tons steel	8.00	8.00	7.20
9. Painting, S. P. overhead—230 tons steel	8.00	8.00	7.20
10. Painting, catenary bridges—700 tons steel	8.00	13.00	11.20
11. Extra portland cement—100 bbl	2.30	2.50	2.50
Port of Oakland Overhead			
12. Structural steel—1,700,000 lb.	.076	.07	.075
13. Concrete—2,100 cu. yd.	24.00	21.00	24.75
14. Reinf. steel—160,000 lb.	.05	.046	.0475
15. Reinf. trusses—173,000 lb.	.26	.213	.22
16. Pipe railing—220,000 lb.	.11	.12	.14
17. Painting—850 tons steel	8.00	7.00	7.20
18. Extra portland cement—220 bbl.	2.30	2.50	2.50

Sewers, Wellsville, N. Y.

CONTRACT for the construction of 9 mi. of sanitary sewer was recently awarded by the Wellsville, N. Y. sanitation department. The seven bids submitted afford a complete comparison of vitrified tile and cast iron sewer pipe in 8 to 20-in. diameters. The principal items comprising the work, which is financed through PWA and is scheduled for 150 days completion, are tabulated below with the unit prices and totals of the three low bidders. (A) Triple Const. Co. (contract) Binghamton, N. Y. $175,566; (B) Drainage Contractors Inc., Detroit, Mich., $188,042; (C) James Passero Co. Rochester, N. Y. $207,370. William S. Lozier, Inc., of Rochester, N. Y., is consulting engineer.

WELLSVILLE, N. Y., SEWERS

Item	A	B	C
1. Vitrif. tile, 8 in., 0.5 ft.—3,100 lin. ft.	$1.00	$0.80	$1.70
2. Vitrif. tile, 8 in., 6–8 ft.—10,600 lin. ft.	1.10	.90	1.70
3. Vitrif. tile, 8 in., 8–10 ft.—11,900 lin. ft.	1.20	1.20	1.70
4. Vitrif. tile, 10–12 ft.—3,000 lin. ft.	1.25	1.50	1.70
5. Vitrif. tile, 12–14 ft.—1,100 lin. ft.	1.45	1.70	1.70
6. Gravel cradle, 8 in.—14,800 lin. ft.	.50	.20	.20
7. Concrete cradle, 8 in.—14,900 lin. ft.	.60	.50	.35
8. Y's, 5 x 8 in.—900 each	1.50	.90	.85
9. Vitrif. tile, 10 in., 0.5 ft.—500 lin. ft.	1.10	1.10	2.50
10. Vitrif. tile, 10 in., 6–8 ft.—500 lin. ft.	1.25	1.20	2.50
11. Vitrif. tile, 10 in., 8–10 ft.—3,400 lin. ft.	1.35	1.40	2.50
12. Vitrif. tile, 10 in., 10–12 ft.—2,400 lin. ft.	1.55	1.80	2.50
13. Vitrif. tile, 10 in., 12–14 ft.—400 lin. ft.	1.75	2.00	2.50
14. Gravel cradle, 10 in.—1,200 lin. ft.	.50	.25	.20
15. Concrete cradle, 10 in.—6,000 lin. ft.	.60	.60	.40
16. Y's, 5 x 10 in.—170 each	1.75	1.30	1.15
17. Vitrif. tile, 12 in., 6–8 ft.—300 lin ft.	1.15	1.30	3.45
18. Vitrif. tile, 12 in., 8–10 ft.—520 lin. ft.	1.55	1.60	3.45
19. Vitrif. tile, 12 in., 10–12 ft.—460 lin. ft.	1.70	2.00	3.45
20. Vitrif. tile, 12 in., 14–16 ft.—300 lin. ft.	2.00	3.20	3.45
21. Conc. enc., 12 in.—300 lin. ft	1.75	.90	1.20
22. Conc. cradle, 12 in.—1,280 lin. ft.	.75	.70	.60
23. Y's, 5 x 12 in.—50 each	2.25	1.60	1.50
24. Vitrif. tile, 15 in., 0.5 ft.—350 lin. ft.	1.50	1.50	3.50
25. Vitrif. tile, 15 in., 6–8 ft.—990 lin. ft.	1.65	1.60	3.50
26. Vitrif. tile, 15 in., 8–10 ft.—120 lin. ft.	1.85	1.70	3.50
27. Vitrif. tile, 15 in., 10–12 ft.—990 lin. ft.	2.00	2.20	3.50
28. Conc. cradle, 15 in.—2,450 lin. ft.	1.00	.90	.75
29. Y's, 5 x 15 in.—16 each	2.75	2.70	2.25
30. Vitrif. tile, 18 in., 8–10 ft.—360 lin. ft.	2.15	2.40	5.00
31. Vitrif. tile, 18 in., 10–12 ft.—350 lin. ft.	2.35	2.80	5.00
32. Conc. cradle, 18 in.—710 lin. ft	1.00	1.00	.75
33. Y's, 5 x 18 in.—20 each	2.50	4.00	3.35
34. Vitrif. tile, 20 in., 0.5 ft.—770 lin. ft.	2.00	2.30	4.00
35. Vitrif. tile, 20 in., 6–8 ft.—800 lin. ft.	2.20	2.40	4.00
36. Vitrif. tile, 20 in., 8–10 ft.—2,920 lin ft.	2.40	2.80	4.00
37. Vitrif. tile, 20 in., 10–12 ft.—520 lin. ft.	2.50	3.10	4.00
38. Vitrif. tile, 20 in., 12–14 ft.—70 lin. ft.	2.65	3.40	4.00
39. Vitrif. tile, 20 in., 14–16 ft.—30 lin. ft.	2.85	4.40	4.00
40. Conc. cradle, 20 in.—5,110 lin. ft.	1.00	1.10	.85
41. Y's, 5 x 20 in.—64 each	3.25	5.00	4.00
42. Cast iron pipe, 8 in., 0.5 ft.—260 lin. ft.	2.00	2.00	2.27
43. Cast iron pipe, 10 in., 0.5 ft.—485 lin. ft.	2.25	2.60	2.50
44. Vitrif. tile riser, 5 in.—50 lin. ft	1.00	2.20	3.00
45. Vitrif. tile lateral, 5 in.—1,000 lin. ft	.85	2.20	1.25
46. Lateral transfers—350 each	5.00	4.50	5.00
47. Manholes, 0.5 ft.—190 each	50.00	75.00	75.00
48. Manholes, extra depth—580 lin. ft.	7.00	11.00	12.00

Correction—San Francisco Reservoir

REPORT of the contract award and list of unit prices of the University Mound Reservoir in San Francisco, published in this section Mar. 18, 1937, p. 429, stated that the contract was awarded on a lightweight concrete aggregate alternate for girders, joists and roof slabs, at a saving of 4.1 per cent. This statement is erroneous, for though alternate bids were taken on the use of lightweight aggregate, contract was awarded on the basis of standard aggregate on a bid of 4½-per cent lower than the lowest alternate. The list of unit prices as published is correct; Contract was awarded to MacDonald & Kahn, as listed, and the third column of the bid tabulation carried the unit prices of the low bidder on the alternate, the Clinton Const. Co. N. A. Eckart, general manager and chief engineer of the San Francisco Water Dept., called our attention to this error.

Current Construction Unit Prices

Average 1936 Highway Prices, Massachusetts

AN AVERAGE of all unit prices on bridge and highway contracts let from Dec. 1, 1935 to Dec. 1, 1936, has been compiled by the Department of Public Works of Massachusetts under the direction of George H. Delano, chief engineer of the department. The compilation includes the unit price contract items on 54 projects financed by the state and federal governments, aggregating $9,111,476, and 36 projects financed under the provisions of Chapter 90 of the laws of the Commonwealth. The first of the following two tables gives the average cost of surfacing of several types of road, excluding grading costs; the second table gives the average of unit contract items.

AVERAGE COST OF VARIOUS TYPES OF PAVEMENT, PER SQ. YD.

(Not including cost of excav., foundation or other details of const.)

Type	Unit Cost
Penolithic (2½-in. top, 4-in. base, 2 gal. asphalt, total thick. 6½ in.)	$0.964
Bituminous Macadam (2-in top, 4-in. base, 2½ gal. asphalt, total thick. 7 in.)	1.021
Bituminous Concrete, Class I (2-in. top, 4-in. BMA base, 2½ gal. asphalt, total thick. 6 in.)	1.489
Bitulithic (2½-in. top, 3-in. base, total thick. 5½ in.)	1.751
Reinforced Cement Concrete (6.3 lb. steel reinf., total thick. 8 in.)	2.001
Bituminous Concrete, Class I (2-in. top, 6-in. plain concrete base, total thick. 8 in.)	2.056

AVERAGE PRICES FOR HIGHWAYS AWARDED IN 1936 IN MASSACHUSETTS

ITEM	UNIT	QUAN.	AV. PRICE
Base Course, Plain Cement Concrete	C.Y.	18,400	$7.25
Bituminous Material:			
Asphalt (Spec. No. 5)	Gal.	1,374,751	0.108
Asphalt Cement for Penolithic	Gal.	1,283,360	0.106
Asphalt, Cutback (Spec. No. 11)	Gal.	6,195	0.134
Asphaltic Oil (Spec. No. 2)	Gal.	25,110	0.096
Tar, Cold (Spec. No. 14)	Gal.	147,080	0.124
Blast Plates, Cast Iron	Lb.	136,100	0.069
Blast Plates, Wrought Iron	Lb.	131,400	0.069
Borrow:			
Cinder	C.Y.	542	1.78
Gravel	C.Y.	1,012,570	.050
Loam	C.Y.	168,930	.093
Loam or Clay Hardening	C.Y.	16,910	0.32
Ordinary	C.Y.	1,762,370	0.34
Sand	C.Y.	33,240	1.14
Bounds	Each	1,615	5.60
Bounds Removed and Reset	Each	322	4.35
Bounds, Property, Removed and Reset	Each	73	3.85
Broken Stone:			
Base Course	C.Y.	110,800	3.34
Base Course	Ton	42,565	1.87
Top Course (BMA)	C.Y.	24,485	3.68
Top Course, Oiled for Penolithic	C.Y.	31,040	5.46
Base for Sidewalks (BMA)	C.Y.	7,677	3.23
Base for Sidewalks (Penolithic)	C.Y.	5,300	4.87
Catch Basins	Each	1,814	64.13
C.B.or M.H. Adjusted to Grade	Each	242	10.95
Cement for Pointing	Bbl.	69	13.28
Clearing and Grubbing	Acre	183	131.75
Curbing:			
Concrete, Straight	L.F.	485	1.52
Concrete, Curved	L.F.	322	0.95
Concrete, Without Curb Bar	L.F.	310	1.08
Granite Vertical:			
Type A 7x20-in., Str	L.F.	3,610	1.47
Type A 7x18-in., Str	L.F.	33,385	1.25
Type A 7x18-in., Curved	L.F.	2,881	1.72
Type A 6x20-in., Str	L.F.	5,260	1.20
Type A 6x20-in., Curved	L.F.	3,120	1.48
Type A 6x18-in., Str	L.F.	142,305	1.03
Type A 6x18-in., Curved	L.F.	18,575	1.34
Type B, Straight	L.F.	64,123	1.05
Type B, Curved	L.F.	3,150	1.35
Type C, Straight	L.F.	164,619	0.90
Type C, Curved	L.F.	5,456	1.19
Granite, Removed and Reset	L.F.	7,575	0.36
Granite, Removed and Stacked	L.F.	4,950	0.27
Curb Corners:			
Granite, Radius Two (2) Feet	Each	1,657	6.92
Granite, Radius Three (3) Feet	Each	69	14.80
Granite, Removed and Reset	Each	95	5.52
Curb Inlets:			
Concrete, Precast With Transitions	Each	208	19.74
Concrete, Straight	Each	42	9.95
Concrete, Curved	Each	4	16.25
Granite, Straight	Each	1,418	14.78
Granite, Curved	Each	77	17.93
Granite, Removed and Reset	Each	34	5.69
Dynamite (For Peat Excav.)	Lb.	15,070	0.38
Edging:			
Concrete, Precast:			
Sloped Face, Str	L.F.	7,093	1.08
Sloped Face, Curved	L.F.	6,948	1.44
Sloped, Str	L.F.	102,050	0.55
Sloped, Curved	L.F.	357	0.98
Concrete, Removed and Reset	L.F.	266	0.50
Granite, Sloped, Type A	L.F.	32,864	0.78
Excavation:			
Bridge	C.Y.	55,222	2.45
Channel	C.Y.	7,770	1.18
Concrete, Bridge	C.Y.	725	4.90
Concrete, Plain	C.Y.	53	2.85
Concrete, Reinf., Surface	C.Y.	3,676	1.02
Ledge	C.Y.	324,830	1.46
Peat	C.Y.	238,650	0.32
Roadway, Earth	C.Y.	1,803,390	0.33
Trench	C.Y.	181,063	1.25
Trench Ledge	C.Y.	10,808	3.80
Fences:			
Chain Link, 5 Ft	L.F.	6,150	1.28
Chain Link, Removed and Reset	L.F.	1,195	0.52
Chain Link, Removed and Stacked	L.F.	35	0.15
Chain Link Gates with Posts	Each	96	7.00
Chicken Wire	L.F.	470	0.16
Pipe Rail	L.F.	1,512	3.43
Railroad Barrier	L.F.	280	1.64
Removed and Reset	L.F.	7,660	0.20
Stock	L.F.	96,655	0.16
Gates	Each	104	10.71
Welded Iron	L.F.	2,068	6.44
Welded Steel	L.F.	2,505	6.97
Wooden Picket, Removed and Reset	L.F.	505	0.40
Fine Grading	S.Y.	3,647,500	0.033
Guard Posts, Concrete	Each	557	2.36
Guard Rail and Highway Guard:			
On Concrete Posts:			
Cable	L.F.	30,555	0.49
Cable Removed and Reset	L.F.	5,460	0.28
Cable Removed and Stacked	L.F.	8,230	0.16
Multiple Cable, 6 Strand	L.F.	46,055	0.96
Multiple Cable, 8 Strand	L.F.	52,625	1.06
Steel Tape, 2 Strand	L.F.	24,400	0.95
Steel Tape, 3 Strand	L.F.	5,420	0.93
Wooden, Special 2 Rail	L.F.	8,160	0.90
On Steel Shell Posts:			
Multiple Cable, 6 Strand	L.F.	19,550	1.50
Multiple Cable, 8 Strand	L.F.	75	1.95
Steel Tape, 2 Strand	L.F.	160	1.10
On Wooden Posts:			
Wooden	L.F.	565	0.81
Wooden, Removed and Reset	L.F.	155	0.74
Wooden, Removed and Stacked	L.F.	10,490	0.14
Gunite	S.F.	78,420	0.42
Hydrants, Fire	Each	6	106.67
Hydrants, Fire, Removed and Reset	Each	37	33.65
Leaching Basins	Each	20	44.75
Lumber Sheeting	MFBM	203	72.75
Manholes	Each	570	62.46
M.H.Frame and Cover Fitted to C.B	Each	25	24.04
Masonry:			
Cement Concrete, Class A	C.Y.	33,631	15.56
Cement Concrete, Class B	C.Y.	608	63.84
Cement Concrete, Class C	C.Y.	38,296	11.72
Cement Concrete, Class D	C.Y.	4,259	12.19
Cemented Stone	C.Y.	4,586	9.78
Dry Stone	C.Y.	1,285	6.54
Stone Walls:			
Removed and Rebuilt Dry	C.Y.	25	8.40
Removed and Rebuilt in Mortar	C.Y.	206	5.96
Piles:			
Composite	L.F.	32,210	1.29
Concrete, Cast-in-Place	L.F.	3,300	3.00
Concrete, Precast	L.F.	360	3.50
Testing	Each	12	230.00
Timber	L.F.	191,385	0.65
Timber, Creosoted	L.F.	50,040	0.79
Pipe:			
C. I. Culvert, Heavy:			
12 Inch	L.F.	4,284	1.86
16 Inch	L.F.	44	2.45
18 Inch	L.F.	752	3.06
24 Inch	L.F.	192	5.12
30 Inch	L.F.	30	8.00
36 Inch	L.F.	160	12.14
C. I. Culvert, Light:			
15 Inch	L.F.	618	2.11
18 Inch	L.F.	710	2.75
24 Inch	L.F.	734	3.89
30 Inch	L.F.	436	6.56
36 Inch	L.F.	1,360	9.10
Corr. Metal Bit. Coated:			
10 Inch	L.F.	832	1.21
12 Inch	L.F.	1,090	1.44
15 Inch	L.F.	38	1.70
18 Inch	L.F.	382	1.57
24 Inch	L.F.	44	3.50
36 Inch	L.F.	54	8.39
42 Inch	L.F.	8	8.50
Reinf. Concrete:			
12 Inch	L.F.	27,766	1.25
15 Inch	L.F.	4,180	1.42
18 Inch	L.F.	9,128	2.05
24 Inch	L.F.	4,054	3.03
27 Inch	L.F.	1,204	3.11
30 Inch	L.F.	1,570	4.01
33 Inch	L.F.	940	4.10
36 Inch	L.F.	5,585	6.28
42 Inch	L.F.	2,748	8.13
48 Inch	L.F.	1,444	8.89
60 Inch	L.F.	196	13.72
Vit. Concrete Sewer:			
6 Inch	L.F.	4,192	0.47
8 Inch	L.F.	2,148	0.46
10 Inch	L.F.	32,259	0.51
12 Inch	L.F.	76,896	0.61
15 Inch	L.F.	17,580	0.92
18 Inch	L.F.	8,386	1.29
20 Inch	L.F.	504	2.10
24 Inch	L.F.	9,562	1.13
Reinf. for Structures	Lb.	5,562,491	0.037
Rip Rap	C.Y.	11,498	2.41
Sand Traps	Each	14	44.29
Scarifying and Reshaping	S.Y.	15,480	0.08
Seeding	S.Y.	730,630	0.05
Side Drain, 6-Inch	L.F.	27,093	0.96
Side Drain, 10-Inch	L.F.	6,078	1.09
Side Drain, 12-Inch	L.F.	322	1.00
Sidewalks:			
Bituminous Concrete	Ton	10,260	7.78
Granolithic	S.Y.	5,785	2.01
Tar	S.F.	20,060	0.10
Sodding	S.F.	15,910	0.11
Steel Reinforcement for Surfacing	Lb.	349,500	0.041
Steel Sheeting	Lb.	389,500	0.05
Stripping Gravel Pits	C.Y.	103,248	0.09
Structural Steel	Lb.	11,822,900	0.049
Surfacing, Roadway and Bridge:			
Bit. Concrete Class I	Ton	59,179	7.07
Bit. Concrete Type A	Ton	2,410	4.97
Bit. Concrete Type E	Ton	7,492	7.81
Cement Concrete, Standard	C.Y.	11,740	7.84
Cement Concrete H. E. S.	C.Y.	730	9.94
Gravel	C.Y.	13,090	0.97
Town Line Posts	Each	13	12.77
Town Line Posts Removed and Reset	Each	6	9.67
Traffic Signal Duct	L.F.	10,128	0.54
Trees to be Removed	Each	2,201	12.74
Walls, Balanced Stone, Removed and Rebuilt	L.F.	14,965	0.53
Waterproofing:			
Bituminous	S.Y.	33,573	0.28
Colorless	S.Y.	6,150	0.48
Membrane	S.Y.	7,414	1.53
Zinc Plates	Lb.	5,212	0.20